Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

MODERN FINANCE: A CATALYST FOR TRULY MODERN AGRICULTURE

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ABSTRACT
This paper aims at investigating the crucial role that the three pillars of the financial system – i.e. financial markets, products and institutions – are likely to play in order to speed up the process of modernization in agriculture, especially in agri-food chains. Four main areas of interest can be identified that consist of sustainable, inclusive, blended and rural finance, and that embody a set of strategic tools: their support to the agricultural sector ranges from its most traditional side to unprecedented forward steps, such as those pertaining to novel foods and to farming on Mars. While innovation allows for progress both in the financial industry and in agribusiness, *glocal co-opetitive* challenges surface from what can be found at the crossroads: a growing concern for sustainability issues is just an example, which leads to emphasize the 17 Sustainable Development Goals and the underlying generation pact. Focusing on finance, this is a qualitative research that draws upon empirical evidence and success stories; a framework for analysis is outlined, in an attempt at promoting rural finance as a specialized discipline from a theoretical point of view and a peculiar market segment for operating purposes, with relevant sub-sets such as agricultural finance, agricultural value chain finance and agricultural microfinance. Conclusions encompass recommendations that unveil academic implications; supporting arguments stem from – among others – the widely recognized need for upgrading financial education and literacy, especially in rural areas and even within the context of lifelong learning.

Keywords: blended finance, financial education, financial inclusion, rural finance, sustainable finance

INTRODUCTION

The research gap at the crossroads between financial innovation and innovation in agriculture is the main focus of this paper; it takes inspiration from the fallacies in the financial system that prevent it to adequately satisfy the needs of a large share of the world population and especially of smallholder farmers, who are mostly underbanked; as a consequence, valuable efforts aimed at making of agriculture a truly modern market segment run the risk of being vanished. Within this framework, what sounds especially appealing is the pursuit of the 17 Sustainable Development Goals (SDGs) that were adopted by the United Nations in 2015, upon setting the "2030 Agenda", and that cover challenging issues, such as ending poverty and hunger, responding to climate change, sustaining natural resources, as well as promoting sustainable agriculture and financial inclusion (UN, 2015).

Looking at finance, it is generally acknowledged as vital to help the real sphere of the economy move forward and persistent attention tends to be devoted to the primary sector, with agriculture spearheading the priority list. Undisputed evidence exists on rapid and significant changes occurred in the financial arena over the last few decades, due to many factors, such as technological progress and globalization: new financial products, markets and institutions have been allowed to proliferate, though banks and their services continue to play a prominent role in general terms; by contrast, according to reliable estimates (DEMIRGUC-KUNT ET AL., 2015), two billions adults – more than half of those who work in the world – should be labelled as unbanked, as they do not even hold a bank account, and much room remains for advancements particularly in rural areas.

On the other side, agriculture can be still depicted as a traditional sector, in spite of the fact that the art of 'doing' sustainable innovation has gained momentum. Success stories abound in related market segments too: a recent example to follow – for production and distribution purposes – is the recourse to supermarket aisles that are reserved to products free of plastic packaging, as a way to join the global fight against pollution; they are supposed to symbolize the future of food retailing (TAYLOR, 2018).
Therefore, the analysis is designed to draw upon the evolutionary scenario of both the financial industry and the agricultural sector and the discussion revolves around how the former can best support the latter. It is not only a matter of replicating positive experiences but also of carrying out unprecedented activities, such as those that refer to novel foods and simulated "Martian gardens": the current modern farming paradigm has many techniques and practices that are important to maintain but innovating is a must, not only in agriculture; the same holds true for the financial system that should be even called to pursue its modernization as a precondition for the evolution of other industries, being money a scarce resource and innovation a risky, capital intensive process.

MATERIAL AND METHOD

In sight of reaching the proposed objective, the starting point can be identified with defining most relevant concepts, including modern finance and modern agriculture; the next step is intended to grant due weight to the relationship between them, that lies at the heart of the above mentioned research gap. Moreover, useful insights can be gained by scrutinizing the implications in terms of sustainability, which leads to address environmental and social issues with regard to both of the industries under investigation.
From a methodological perspective, this is an explorative study; a case-study research method tends to be privileged, as it seems most suitable to collect qualitative data and allows for flexibility. At the same time, the chosen approach has been forged in order to properly combine the local and global perspectives, as suggested by the wider and wider endorsement of the *glocal* philosophy, and to join the search for the appropriate mix of competition and cooperation, in line with the *co-opetitive* vision.
Conclusions encompass key messages and recommendations for policy interventions, as well as for further research and development. The rationale behind them features best practices that might be usefully disseminated, to the benefit of both the financial and the agricultural sectors, with related market segments too being involved; academic challenges also surface, in the light of the need for financial education, literacy and competence, as well as of the discipline status that rural finance deserves.

RESULTS AND DISCUSSION

Based on extensive and in-depth analysis – on most recent literature, pertaining legislation and institutional websites – it can be argued that four major areas provide ground for discussion and promise to generate encouraging results, thus paving the way to realistic solutions and guidelines for practical applications, as follows:

1. Sustainable finance

In line with the post-2015 development agenda, truly modern agriculture should satisfy strategic requirements for sustainability that – as pointed out by the Food and Agriculture Organization of the United Nations – imply an efficient use of resources, environmental

protection, healthy ecosystems and responsible governance mechanisms, to mention just a few requirements (FAO, 2014). In turn, sustainable agriculture should rely on sustainable finance: to summarize, it consists of "the provision of finance to investments taking into account environmental, social and governance considerations" (Sustainable Finance, n.d.).
Environmental considerations have to do with the strong green finance component that can support a sustainable growth path, as shown by the move to re-orient banking according to sustainability indexes and particularly to promote responsible lending; governance considerations are motivated by an increasing awareness of the risks that may affect the sustainability of the financial industry and are closely tied to the adoption of appropriate mitigation strategies. It is not a case that the need has been recently recognized to provide farmers, agri-food operators and rural entrepreneurs with the full range of financial possibilities existing under the European Agricultural Fund for Rural Development, in sight of building a farming and food sector which is fully in tune with the 21st century, with a strong emphasis on sustainability, as well as on innovation and quality (HOGAN, 2017).
As far as social considerations, it is worth stressing that "finance performs two key functions beneficial to households and firms: risk management and inter-temporal consumption smoothing" (STEIN, 2010). These functions allow to reap benefits that range from managing day-to-day resources to taking advantage of investment opportunities, just to highlight the needs that are most often satisfied by banks and other financial institutions, though underbanked – and especially unbanked – market segments continue to be a source of serious concern, particularly in agriculture.

2. Inclusive finance

Their unmet needs act as a stimulus to aim at financial inclusion: it "means that individuals and enterprises can access and use a range of appropriate and responsibly provided financial services offered in a well-regulated environment" (FINANCIAL INCLUSION, n.d.); an interlinked approach rests upon financial resilience as the declared, feasible capacity to survive financial shocks and to obtain money for unexpected expenses (SOLARZ, 2017). Overall, it can be agreed on that "inclusive finance strives to enhance access to financial services for both individuals and micro-, small and medium-sized enterprises" (INCLUSIVE & LOCAL FINANCE, n.d.), as a way to reduce poverty, tackle inequality and foster growth, thus unveiling the potential for improvement among smallholder farmers.
Actually, there is remarkable empirical evidence that supports a clear relationship between a wider recourse to finance and reduced income inequality and poverty. As such, financial inclusion can be said not only pro-growth but also pro-poor, which leads to deploy significant resources to the objective of inclusive rural transformation: it can be expected "to generate improved and more stable livelihoods for all rural people, including small-scale farmers, land-poor and landless workers, women and youth, marginalized ethnic groups and victims of disaster and conflict", as suggested by the International Fund for Agricultural Development (IFAD, 2016).
In developing countries, more than elsewhere, access to financial services is crucial to strengthen the financial sector, as well as to support the process of domestic resource mobilization, and the costs to people of being financially excluded should not be underestimated (PRABHAKAR, 2018): despite some criticism (MADER, 2017), an increasingly shared view aims at promoting a more inclusive financial system by "intensifying the depth of outreach and providing services to marginalized groups, especially women, reaching beyond conventional microcredit to the people at the bottom of the economic pyramid" (INCLUSIVE FINANCE, 2013). To this end, the array of most useful tools cover the extension of savings, credit, insurance and payment services that tend to involve a relatively small amount of money and hence do not usually attract banks.

3. Blended finance

Focusing on the supply of these services, it comes natural to evoke microfinance institutions but even most traditional financial intermediaries can play a pivotal role by participating in the joint efforts that are requested. They justify the Global Partnership for Sustainable Development that has been proposed by setting the last of the SDGs, based on a spirit of strengthened global solidarity and on the needs of the most vulnerable: all countries, all stakeholders and all people are supposed to cooperate in order to mobilize and share knowledge, expertise, technology and financial resources; these inclusive partnerships are proposed as being "built upon principles and values, a shared vision and shared goals that place people and the planet at the centre" and should be developed "at the global, regional, national and local level" (GOAL 17).

A closer look at the agricultural sector reveals a noticeable involvement of international organizations – just like UN, FAO and IFAD – committed to ethical and global goals. No surprise: the World Bank has made clear that "agricultural growth remains central to poverty reduction, particularly in the poorest countries, where a large share of the population relies on agriculture for their livelihood" (WB, 2011); however, according to the "2030 Agenda", a lot of energies should be still devoted to "encourage and promote effective public, public-private and civil society partnerships, building on the experience and resource strategies of partnerships" (UN, 2015).

In sight of promoting blended finance – as a combination of official development assistance with other public resources, as well as private and philanthropic funds (PEREIRA, 2017) – guidelines have been made available by the European Commission that specifically refer to public-private partnerships (PPPs) for a quite long time (EC, 2003). Valuable evidence concerning the recourse to them in agribusiness stems from a series of appraisals that FAO has undertaken since 2010 in Africa, Asia and Latin America: success stories have been recorded in several countries, including Pakistan, Indonesia, Thailand, Kenya, United Republic of Tanzania, Ghana, Nigeria (SLATER ET AL., 2016), and may provide precious guidance on how to partner effectively with the private sector in order to mobilize support for agribusiness development; lessons learned are likely to favor arrangements whereby "public and/or philanthropic inputs 'leverage' or catalyse a private investment that otherwise would not be made, creating positive development outcomes" (LONSDALE, 2016), with special consideration to be devoted to building PPPs for agricultural innovation (HARTWICH ET AL., 2008).

4. Rural finance

It may also prove rewarding to resort to market segmentation principles that allow to define rural finance as one of the subsets of the financial industry. This market segment comprises the full range of financial services needed or anyway used in rural areas by households and enterprises; such a broad definition includes loans, savings, insurance, payment and money transfer services, and can be usefully broken down by identifying at least three areas, namely agricultural finance, agricultural value chain finance and agricultural microfinance.

Agricultural finance consists of financing agricultural-related activities, such as input supply, production, distribution, wholesale, processing and marketing, whereas agricultural value chain finance is devoted to loans and other financial services flowing to and/or through the various links involved in the multi-facet processes from farms to consumers; finally, agricultural microfinance is aimed at the provision of financial services – such as small-sized loans and savings services – to poor and low income people, as well as to small-scale business operators. All in all, it seems relatively easy to conceptualize these

notions but supply- and demand-side constraints continue to hinder the development of a dedicated financial industry (IFAD, 2009: 16), especially in developing countries.
On one hand, informal financial service providers dominate in rural communities, though there are major opportunities to improve the outreach of financial products through formal financial institutions; on the other hand, a compelling need is commonly shared – as a *glocal co-opetitive* challenge – for improving financial competence by furthering financial education and literacy, so as to empower smallholder families and small agri-businesses to make – and upgrade their – recourse to finance. Undoubtedly, expansion of rural financial services is likely to create a win-win scenario, thus helping to reduce poverty and to achieve sustainable growth, even where financial inclusion is by itself a tough task.

CONCLUSIONS

Nobody would deny that the primary sector – and truly modern agriculture in the first place – can favor the trend towards sustainable growth, in both developing and industrialized countries, to the benefit of present and future generations, in line with the generation pact; for instance, supporting arguments stem from projects that have been developed in sight of relying on biological processes, recycling as much as possible and expending minimal amounts of energy. In turn, finance is crucial to the pursuit of ambitious achievements along the pathway to sustainability, as suggested by recent initiatives directed to improving financial inclusion of smallholder farmers.
Anyway, much more attention should be paid to rural finance: it still looks like an emerging market segment in the financial industry, which by the way also faces sustainability issues. A case in point deals with the adoption of responsible lending principles, that imply – but are not limited to – an unquestionable attitude towards inclusive finance and prevention of over-indebtedness; in more general terms, responsible decisions by financial institutions can be expected to address the environmental and social impacts of their investment and particularly of their loans.
For the best results to be scored, synergies can be exploited by promoting blended finance, just like clusters that encompass industrial and technological districts specializing in agricultural commodities: building capacity, pursuing innovation and enriching knowledge sound like promising goals that Universities are likely to contribute to; further academic implications to be accounted for cover the discipline status of rural finance and the provision of financial education – even within the framework of lifelong learning – especially to rural populations. A network of most relevant partners may help to jointly face the *glocal co-opetitive* challenges ahead and hopefully experience the increased joy of sharing success stories, instead of simply sharing pains to lessen them.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

WATER FOOTPRINT OF PROTEIN YIELD OF FIELD CROP SPECIES BASED ON EVAPOTRANSPIRATION PATTERNS

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ABSTRACT
Water availability is one of the major physiological factors influencing plant growth and development. An assessment study has been done at the Szent István University, Gödöllő to evaluate and identify the water footprint of protein yield of field crop species.
Six field crop species (sugar beet *Beta vulgaris*, winter barley *Hordeum vulgare*, winter wheat *Triticum aestivum,* maize *Zea mays*, potato *Solanum tuberosum*, and alfalfa *Medicago sativa*) were involved in the study. Evapotranspiration patterns of the crops studied have been identified and physiologically reliable protein ranges within crop yields were evaluated.
The results obtained suggest, that water footprint of cereals proved to be the lowest, however maize values were highly affected by the high variability of protein yield. Alfalfa, potato and sugar beet water footprints were in accordance with their evapotranspiration patterns.

Keywords: water footprint, evapotranspiration, protein, field crop species

INTRODUCTION

The water footprint shows the extent of water use in relation to consumption by people (HOEKSTRA AND CHAPAGAIN, 2007). The water footprint of an individual, community or business is defined as the total volume of fresh used to produce the goods and services consumed by the individual or community or produced by the business. Water use is measured in water volume consumed (evaporated) and/or polluted per unit of time. A water footprint can be calculated for any well-defined group of consumers (e.g., an individual, family, village, city, province, state or nation) or producers (e.g., a public organization, private enterprise or economic sector), for a single process (such as growing crop plants) or for any product.
Traditionally, water use has been approached from the production side, by quantifying the following three columns of water use: water withdrawals in the domestic and agricultural and industrial sector. While this does provide valuable data, it is a limited way of looking at water use in a globalised world, in which products are not always consumed in their country of origin. International trade of agricultural and industrial products in effect creates a global flow of virtual water, or *embodied water.* Recently, the water footprint concept was introduced in order to have a consumption-based indicator of water use that could provide useful information in addition to the traditional production-sector-based indicators of water use. It is analogous to the ecological footprint concept introduced in the 1990s. The water footprint is a geographically explicit indicator, showing volumes of water use and pollution, and also the locations. Thus, it gives a grasp on how economic choices and processes influence the availability of adequate water resources and other ecological realities across the globe (and vice versa).
In a UNESCO study series water footprint of various food and feed products have been evaluated (MEKONNEN AND HOEKSTRA, 2010). The research results give an evidence on the diverse amount of water used for production of food and feed. The differences between

vegetables, cereals and meat products may have a 1:10:100 x ratio concerning water usage; e.g. 1 kg of vegetable may be produced with some 300 litres of water while bovine meet would require about 15000 litres. The specific values were much smaller if exact nutritional indicators like calories, protein or fats were evaluated. In this comparison the water footprint differences were within a five-fold range.

Climate change research results in Hungary have highlighted the variation induced by water availability on protein formation of field crops (KASSAI ET AL., 2016; ESER ET AL., 2017; JOLÁNKAI ET AL., 2018).

Crop water use, consumptive use, and evapotranspiration are terms used interchangeably to describe the water consumed by a crop. This water is mainly used for physiological processes; a negligible amount is retained by the crop for growth. Water requirements for crops depend mainly on environmental conditions. Plants use water for cooling purposes, and the driving force of this process is prevailing weather conditions. Different crops have different water use requirements, under the same weather conditions (VÁRALLYAY, 2008; PEPÓ, 2010).

The present study is dealing with the identification of water footprint of some field crops. The hypothesis of the work was not to rely on yield figures only, but rather the nutritional value of that. In our study the protein yield of various crop species has been evaluated in the context of evapotranspiration.

MATERIAL AND METHOD

The materials and methods of the present study cover a rather broad field, since there are various topics of the research work done by the Szent István University, Crop Production Institute, Hungary (SIU). Most of the results are based on experimental research, however, some evaluations were implemented by using national public data, or observation results published (FM 2017, FAOSTAT, 2017).

An assessment study has been done by the authors to evaluate and identify the water footprint of protein yield of field crop species. Six field crop species (sugar beet *Beta vulgaris*, winter barley *Hordeum vulgare*, winter wheat *Triticum aestivum,* maize *Zea mays*, potato *Solanum tuberosum*, and alfalfa *Medicago sativa*) were involved in the study. Evapotranspiration patterns (ET) of the crops studied have been identified and physiologically reliable protein ranges within crop yields were evaluated.

Regarding water availability impacts, experimental mean values of respective treatments and homogenized bulk yield samples were used only. Precipitation records have been evaluated in relation with yield quantity and quality. Quality characteristics were determined at the Research Laboratory of the SIU Crop Production Institute, according to Hungarian standards (MSZ, 1998). Analyses were done by statistical programmes with respect to the methodology of phenotypic crop adaptation (EBERHART AND RUSSELL, 1966; FINLAY AND WILKINSON, 1963; HOHLS, 1995). The meteorological database of the research referring to precipitation as well as temperature data was provided by the Hungarian Meteorological Service (OMSZ). Statistical evaluations, crop ecological model adaptations, and correlation calculations were done by regular methods (SVÁB, 1981; FINLAY AND WILKINSON, 1963).

The present paper produces results of the ongoing research in relation with weather impacts on crop production. Such an assessment has a diverse nature. Once, it is beneficial regarding the abundance and the duration of baseline data. On the other hand, it is restricted to the available structure and moreover it is bound mainly to available figures giving less chance for deep layer evaluations. However, the study could provide some novel specific information on crop performance in relation with their water footprint.

RESULTS AND DISCUSSION

The results obtained show that the evaluated crops may have ten times differences in their amount of yield built up under almost identical field conditions regarding precipitation, soil conditions and other meteorological factors influencing water availability.
Figure 1 presents data on ET patterns in comparison with the long term precipitation means. In accordance with that it can be stated, that the six species studied have profoundly diverse evapotranspiration patterns concerning water demand, seasonality, and in dynamics as well.

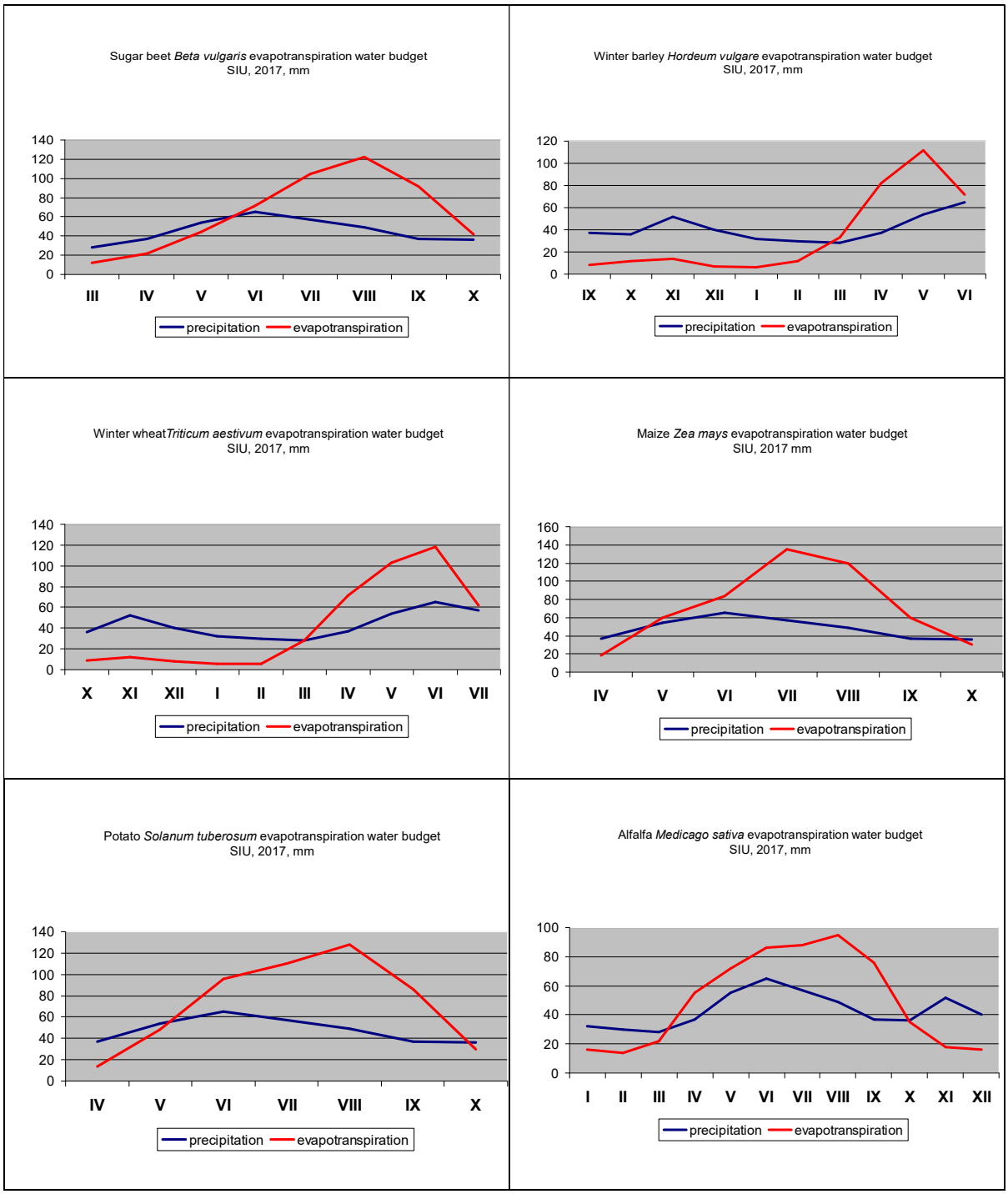

Figure 1. Water budget of field crop species based on evapotranspiration.
Source: SIU, 40 years mean, 2017

The most balanced water budget can be observed in the case of cereal crops like winter wheat and winter barley, where the early development stages are fully supplied by the precipitation and water deficiencies may be experienced mainly during the generative phases and ripening. Maize is the most deficient crop that should be supplied with water either from off season precipitation or irrigation. Similarly to that, the two root and tuber crops are having a negative budget in most of their life cycle. Alfalfa as a perennial crop has more similarities in its ET to that of the cereal species.

The water footprint of the examined crop species proved to be different as it is shown in *Table 1*. The amount of protein of the respective crops ranged from 450 kg to almost 800 kg in the yield of the evaluated species. Root and tuber crops had the lowest protein yield from among the crop species. Grain crops were in the mid-range and definitely alfalfa proved to produce the highest amount of protein.

There were considerable differences in the efficiency of water consumption regarding protein yields. Barley proved to be the most efficient protein producing crop regarding both evapotranspiration and direct water consumption of the crop. Wheat was the next water saving crop concerning protein production. Maize, the third grain crop had almost double specific water consumption in comparison with cereals. Alfalfa had the highest protein yield from among the species examined, however its water efficiency was about half of that of the cereal species.

Table 1. Water footprint of six crop plant species

Crop	Protein (%)	Crop yield (tha^{-1})	Protein yield ($kgha^{-1}$)	Protein kg/ET (mm)	Litre/protein g (l)
Medicago sativa	18.0	4.35*	783	1.32	44.9
Solanum tuberosum	2.0	24.9	498	0.97	52.7
Beta vulgaris	1.1	41.2	453	0.96	49.1
Triticum aestivum	13.0	4.8	624	1.83	23.1
Hordeum vulgare	16.5	4.1	676.5	1.88	18.9
Zea mays	9.5	5.8	551	1.09	46.5

*hay

Source: SIU, 2017

Potato and sugar beet produced the least protein yield within the evaluated crop species. It is quite acceptable since both of them are initiated for the production of carbohydrous substances like starch and sugar rather than proteinous ones. Consequently the water efficiency of these crops proved to be the worst as well.

ACKNOWLEDGEMENTS

This paper presents research results gained from a long term trial supported by TÁMOP, NVKP and VKSZ funds of the Government of Hungary.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

RELATION OF WHEAT SPECIES AND GENOMES IN AMINO-ACID COMPOSITION

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ABSTRACT
As regards wheat varieties constituting a natural ploid series the issue of analysing diploid, tetraploid and hexaploid species is topical since ancient varieties can play significant roles in contemporary agriculture as well. Seventeen winter wheat varieties, out of which 2 diploid varieties carried genome A, 9 diploidic types had genomes AB, two varieties had genomes AG and four varieties were hexaploid ones with genomes ABD, were analysed from the point of view of their amino acid compositions. The amino acid contents of Asp, Thr, Ser, Glu, Gly, Ala, Cys, Val, Met, Ile, Leu, Tyr, Phe, His, Lys, Arg, Pro (a total of 17) were determined in the varieties listed above.
It has been found that the amino acid contents of the grains genotype AA *Triticum boeticum* and *T. monococcum* exceeded the amino acid content of *T. aestivum* in respect of all the amino acids analysed in this experiment, with Glu being the only exception. In comparison with the aestivum wheat, essential amino acid contents showed a similarly favourable picture in the diploidic varieties mentioned. As regards type AB tetraploid varieties excesses of 13-16%, in comparison to the aestivum wheat, were found in essential amino acid contents. The amounts of non-essential amino acids in all the winter wheat varieties showed decreases irrespective of the ploid level.
What concerns the total amino acid content, all the winter wheat varieties with the exception of *T. monococcum* (A), *T. dicoccoides* (AB) and *T. dicoccum* (AB) contained less amino acid than the aestivum wheat. All the monocarbonic acid and aromatic as well as heterocyclic amino acid contents of the wildly growing *Triticum boeticum* (A) and the grown *Triticum monococcum* (A) (with polaric, apolaric R groups, diamino radicles) exceeded the same contents of *T. aestivum*. The value of the monoamino-dicarbonic acid, however, was lower in our experiment.

Keywords: wheat, different genomes, amino acids

INTRODUCTION

The issue of analysing diploid, tetraploid and hexaploid wheats is topical since ancient varieties can play significant roles in contemporary agriculture. Some can be gene sources and valuable crops (VALLEGA, 1979; MULTANI ET AL., 1992; D'EGIDIO ET AL., 1993). The domestication began over ten thousand years ago with „einkorn" (*Triticum monococcum* L.) (HEUN ET AL., 1997) while the modern hexaploid hard wheat for bread making emerged eight thousand years ago. In addition to wheat varieties of the aestivum type, durum wheat (*T. durum* Desf.) (contains genomes A and B, 2n=28) is produced on the remaining approximately 5 % of the wheat production area. Recently, primarily in the hilly regions of Europe the production of the spelta (*T. spelta* L.) wheat variety, which contains hexaploid genomes (A, B and D genomes, 2n=42) has come to play a major role and is used in organic farming due to its smaller nitrogen requirement (VASIL AND VASIL, 1999). Einkorn (genome A and 2n=14) is only grown occasionally for aminal nutrition. BARABÁS (1987) and RAGASITS (1998) deal with the history and taxonomy of wheat in detail in their books. The einkorn or diploid wheat is the earliest grown bread variety in production and one, which is supposed to have been the donor for genome „A" of the hexaploid (*Triticum aestivum* L.) and tetraploid (*Triticum durum* L.) varieties (KERBY AND KUSPIRA, 1988).

Today the ancient varieties are only grown in marginal areas of former Yugoslavia, Turkey and Italy. Protein contents of the hexaploid and durum wheat varieties are high in Glu but low in Lys and Thr, which are especially important for human diets (WRIGLEY AND BIETZ, 1987). ACQUISTUCCI ET AL. (1995) compared 15 *T. monococcum* strains, two modern hexaploid and two durum wheat varieties as regards their protein contents and amino acid compositions. In the case of the einkorn strains there was positive correlation found between Glu and Pro values and protein contents while the same relations exhibited negative correlations as regards Thr, Ile, Leu, Asp, Ser, Gly and Ala. VALLEGA (1995) stated that protein contents of grains ranged between 14-25% when analysing *T. monococcum* strains but no types high in Lys concentrations could be selected during tests. When analysing the amino acid compositions of 44 spring wheat varieties ANJUM ET AL. (2005) found significant differences in certain genotypes. In the varieties analysed, they found considerable variability in Lys, Leu, Ile, Thr, Val, Met, His, Arg, Ala, Asp, Glu, Gly, Pro, Ser and Tyr contents. When analysing the protein and amino acid contents of wheat varieties, BOILA ET AL. (1996) found significant differences in protein concentrations, which findings were similar to those in certain amino acids. Amino acid content of wheat is also influenced by several other factors: amount of nitrogen, damage by pests (ZAHEDI ET AL. 2004, JOOD ET AL. 1995). When analysing grain crops MATUZ ET AL. (2000) found the highest protein contents (18.2-20.9%) in varieties *T. monococcum*, *T. spelta* and an old Hungarian bread wheat variety Bánkúti 1201. Similarly, the highest total amino acid contents were found in these varieties. When analysing the total protein amount ABDEL-AAL AND HUCI (2002) found in the so-called ancient varieties that the amount of total protein per total milled volume was varied in the case of einkorn varieties and the highest values (17.7%) were provided by the hard-grained spelta variety. When analysing biochemical parameters of stored proteins IVANOV ET AL. (1998) found similar amino acid compositions in the wheat variesties and strains of the aestivum type and the essential amino acid level also showed a negative correlation with the total protein amount.
The quality of plant and thus that of wheat is shaped by the genotype, the environmental conditions and their interactions. The contemporary rich Hungarian choice of varieties offered gives producers an opportunity to use an appropriate genetic base best suited the location of production and the type of management chosen (SIPOS ET AL., 2003; GYŐRI, 2006; SIPOS ET AL., 2006; TÓTH ET AL., 2006).

MATERIAL AND METHOD

The wheat varieties analysed in this experiment come from the gene-bank collection of the Agrobotanikai Kutató Intézet (Institute of Agrobotany) in Tápiószele Hungary. A total of 17 varieties with different levels of diploid, tetraploid and hexaploid chromosomes were analysed, their genome compositions were the following:

Genome „A" was found in: *Triticum boeticum* L.*, Triticum monococcum* L. *ssp. monococcum* (SLAGEREN, 1994).

Genomes „A" and „G" were found in: *Triticum timopheevii* Zhuk. *ssp. timopheevii, Triticum petropavlovskyi* (DOROFEEV ET AL. 1979).

Genomes „A" and „B" were found in: *Triticum turgidum* L. *ssp. dicoccoides, Triticum turgidum* L. *ssp. dicoccum, Triticum turgidum* L. *ssp. durum* (Desf.), *Triticum turgidum* L., *Triticum turgidum* L. *ssp. turanicum, Triticum turgidum* L. *ssp. carthlicum, Triticum turgidum* L. *ssp. polonicum, Triticum ispahanicum* L.*, Triticum karamyschevii* L.

Genomes „A", „B" and „D" were found in: *Triticum aestivum* L. *ssp. spelta, Triticum aestivum* L. *ssp. compactum, Triticum aestivum* L. *ssp. macha, Triticum aestivum* L.

The samples were analysed in the Equipment Centre of the Centre for Agricultural Sciences of the University of Debrecen according to the appropriate MSZ, MSZ-ISI standards and by using the AACC method and also by making use of our own testing methods. The flour was milled from the wheat according to Hungarian Standard No. MSZ 6367/9: 1989 with a LABOR MIM AQC-109 laboratory mill. Different types of amino acids except for Asn, Gln, Trp were determined with Biotronik LC 3000 Analyser (liquid chromatograph with cation exchange column) after acidic (HCI) hydrolysis (STEIN AND MOORE, 1963). Asparagine (Asn), glutamine (Gln) and triptophane (Trp) were not studied. Asn and Gln are neutral amino acids, so cation exchange column is not suitable for their determination, while Trp totally disintegrates during acidic hydrolysis, so HPLC is the right method for its examination.

In order to mark the individual amino acids analysed in this experiment, the following generally accepted abbreviations were used: Asp (aspartic acid), Thr (threonine), Ser (serine), Glu (glutamic acid), Gly (glycine), Ala (alanine), Cys (cysteine), Val (valine), Met (methionine), Ile (isoleucine), Leu (leucine), Tyr (tyrosine), Phe (phenylalanine), His (histidine), Lys (lysine), Arg (arginine), Pro (proline).

SPSS 12.0 software was used in processing the data statistically. The diagrams showing average values and variance were made by using Microsoft Excel 2003 software.

RESULTS AND DISCUSSION

We investigated the amounts of essential and non-essential amino acids in winter wheat grains, while *Figure 1* shows the distribution of these types of amino acids in varieties with different genomes. According to the classification by HÍDVÉGI AND BÉKÉS (1983) amino acids that living organisms cannot produce or can only produce in small quantities in relation to the demands are called essential amino acids and these have to be supplemented through a diet. They are: Arg, Cys, Tyr, His, Lys, Phe, Trp, Ile, Leu, Met, Thr, Val. Non-essential amino acids are classified as follows: Ala, Asn, Asp, Glu, Gln, Gly, Pro and Ser. The amino acids analysed by the Equipment Centre were classified into essential and non-essential amino acids according to the lists above. The data reveal that the essential amino acid contents of genome A, *T. boeticum* and *T. monococcum* exceeded the relevant aestivum values by 67.3% and 45.5%, respectively. As regards type AB wheat varieties excess amino acid amounts of 14.5-27.3% were found in *T. petropavlovskyi, turgidum, carthlicum, dicoccum, dicoccoides* in comparison with the aestivum wheat variety. In the case of wheat varieties with an ABD genome structure the amino acid contents were nearly the same.

As regards the non-essential amino acid contents we can see that it was only the *T. boeticum* (A) that reached an excess amount by 9% in comparison with the aestivum wheat. Irrespective of the level of ploidity compared to the total one in all the winter wheat varieties and the extent of this decrease was 0-42%. As regards the total amino acid contents *T. boeticum* (A) exceeded the aestivum wheat variety by 26.2%. On the other hand, the total amino acid contents of all the winter wheat varieties analysed were below (by 0-32.1%) of that of the aestivum wheat, the only exceptions being *T. monococcum* (A), *T. dicoccoides* (AB) and *T. dicoccum* (AB).

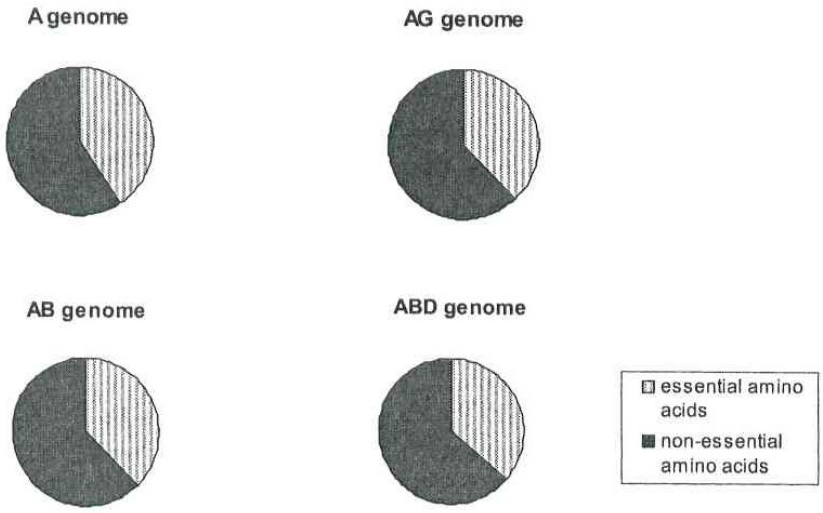

Figure 1. Essential and non-essential amino acid compositions of winter wheat varieties with different genomes
Essential amino acids: Arg, Cys, Tyr, His, Lys, Phe, Ile, Leu, Met, Thr, Val
Non-essential amino acids: Ala, Asp, Glu, Gly, Pro, Ser

We also elaborated the amounts of amino acids in wheat varieties according to their chemical structures. *Figure 2* shows the distribution of these types of amino acids in varieties with different genomes. The following groups were set up:

- monoamino-monocarbonic acids with an apolaric R group: Gly, Lys, Ala, Val, Leu, Ile, Met
- monoamino-monocarbonic acids with a polaric R group: Ser, Thr, Cys
- diamino-monocarbonic acids (basic amino acids): Lys, Arg
- monoamino-dicarbonic acids (acid amino acids) and their amides: Asp, Glu, Asn, Gln
- aromatic amino acids: Phe, Tyr
- heterocyclic amino acids: His, Pro

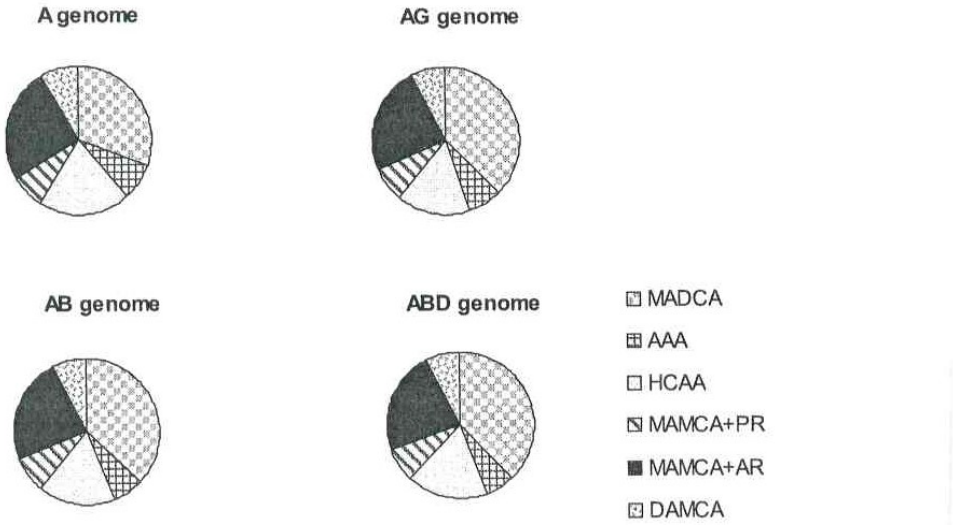

Figure 2. Amino acid compositions of winter wheat varieties according to chemical groups
MADCA: monoamino-dicarbonic acids, AAA: aromatic amino acids, HCAA: heterocyclic amino acids, MAMCA+PR: monoamino-monocarbonic acids with polaric R groups, MAMCA+AR: monoamino-monocarbonic acids with apolaric R groups, DAMCA: diamino-monocarbonic acids

The data reveal that *T. boeticum* and *monococcum*, which have A genome have 27-28% more polaric group containing monoamino-monocarbonic acid than the aestivum type. With the exception of *T. petropavlovskyi* (AB) and *T turgidum* (AB) the other wheat varieties had less of this amino acid than *T. aestivum*. The diploid *T. monococcum* and the variety *T. boeticum*, which contain monoamino-monocarbonic acid with an apolaric group exceeded this content of the aestivum wheat by 37% and 63%, respectively. The apolaric monoamino-monocarbonic acid contents of all the other wheat varieties with the exception of winter wheat varieties *T. petropavlovskyi* (AB), *T. dicoccoides* (AB), *T. turgidum* (AB), *T. carthlicum* (AB) and *T. dicoccum* (AB), which have excesses of 10-20%, were in the same region as the aestivum wheat.

As regards diamino-monocarbonic acids there was more of them in each variety than in *T. eastivum* and with respective values of 63% and 76% the diploidic *T. boeticum* and *T. monococcum*, which have genome A, stand out. Monoamino-dicarbonic acid contents were 10-55% smaller than that of *T. aestivum*.

The amounts of aromatic amino acids in *T. boeticum* (A) and *T. monococcum* (A) were 95% and 47% higher, respectively, than in *T. aestivum*. The aromatic amino acid contents of the other winter wheat varieties analysed exceeded that of *T. aestivum* and it was the varieties *T. dicoccum* (AB*), T. turgidum* (AB) and *T. petropavlovskyi* (AB) with excesses of 22-32% that was outstanding. As regards heterocyclic amino acids the picture is rather varied but even in this respect T. monococcum (A) and *T. boeticum* (A) surpassed *T. aestivum* by 30% and 61%, respectively. In the cases of *T. petropavlovskyi* (-21%), *T. durum* (-37%) and *T. karamyschevii* (-46%) significantly smaller values were obtained.

It also shows a picture of the relative proportions of the amino acids that belong to different chemical groups. As regards the winter wheat varieties analysed in this experiment the ratio of monoamino-monocarbonic acids with polaric R groups ranged between 6.56-9.40%, that of monoamino-monocarbonic acids with apolaric R groups in relation to the total amino acid volume was 19.09-28.21% and diamino-monocarbonic acids had a share of 5.72-9.72%. The ratio of monoamino-dicarbonic acids, representing the highest amount, which was 28.82-47.01% in relation tot he amino acids found in wheat grains, while the ratios of aromatic amino acids and heterocyclic amino acids ranged between 5.38-8.38% and 11.11-20.52%, respectively. In relation to T. aestivum the occurrence of monoamino-dicarbonic acids in comparison to the total amount of amino acids is smaller, while that of apolaric monoamino-monocarbonic acids in the case of aromatic and heterocyclic amino acids is higher. Out of the amino acids with different structures it was the monoamino-dicarbonic acids, which serve as susbstitutes for nitrogen and also play a decisive role in the synthesis of nitrogen containing components, showed the highest variance.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

ANTIOXIDANT PROPERTIES OF DIFFERENT APPLE CULTIVARS

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ABSTRACT
Dietary antioxidants can be an important part of the healthy diet. Polyphenols from the commonly consumed apple can be possible sources of intake of these phytochemicals.
In our study, the antioxidant properties of six apple cultivars (Golden Delicious, Granny Smiths, Idared, Jonagold, Jonagored and Mutsu) harvested at commercial maturity were examined. Flesh and skin were separated and total phenolics by the Folin-Ciocalteu assay, ferric reducing antioxidant power (FRAP) and radical scavenging activities using DPPH method were determined for each. For all apples, polyphenol content and antioxidant activity of the skin were significantly higher than that of the flesh showing that apple peel is a valuable part of the fruit. There was a good linear correlation between the polyphenol content and FRAP showing that mainly polyphenols are responsible for this type of antioxidant reaction. Regarding the cultivars, there was an obvious difference between the antioxidant activities of the examined apples. The green variety Granny Smith showed the best results followed by the red-skin apples while yellow-skin apples had the lowest activity.

Keywords: antioxidants, apple cultivars, polyphenols, FRAP

INTRODUCTION

Fruits are the main sources of dietary antioxidants (KAUR AND KAPOOR, 2001). They are rich in polyphenols, vitamins, organic acids, and minerals. Apple (*Malus domestica*) is one of the most widely consumed fruit, has a long history of cultivation and more than 7000 cultivars. According to an American study, apple has the second highest antioxidant activity among the most frequently consumed fruits (BOYER AND LIU, 2014), only cranberry showed higher activity than apple. The amount and type of polyphenols differ among apple cultivars but the most frequently determined phenolics are quercetin glycosids, catechin and epicatechin, proanthocyanidins, chlorogenic, gallic, coumaric acids and floridzin (FRANCINI AND SEBASTIANI, 2013). In this study extracts from the flesh and peel of 6 apple cultivars were investigated for their polyphenol content and antioxidant activity.

MATERIAL AND METHOD

Apple cultivars

The apple cultivars used were: Golden Delicious, Granny Smiths, Idared, Jonagold, Jonagored, and Mutsu. The cultivars were purchased from the same apple orchard near Pécs, Hungary, and were harvested at their marketable maturity stage.

Preparation of the samples

Apples were peeled and flesh and peel were separately lyophilized (Lyovac GT2, Germany), then grounded to fine powder.

Extraction of polyphenols

One gram of lyophilized apple powder was extracted for 24 h in 20 ml 50 % ethanol at room temperature, then the samples were centrifuged (1000 g, 30 min) and the supernatants were used for further investigations.

Determination of total polyphenols by the Folin-Ciocalteu assay

Extracts were diluted five times with 50% ethanol and 0.2 ml of diluted extracts were mixed with 0.2 ml ethanol (96 %), 1 ml distilled water and 0,1 ml of Folin-Ciocalteu's reagent. After 5 min, 0.2 ml sodium carbonate solution (5 %) was added to the mixtures, then incubated at room temperature in dark for 1 hour. The developed green colour was measured at 725 nm by an UV/VIS spectrophotometer (Philips PU8740). Polyphenol content was expressed in mg gallic acid equivalent (GAE)/1 g solid (lyophilized apple).

Determination of radical scavenging activity with the DPPH assay

For this measurement, the same 5-fold dilutions as for polyphenol determination were used. 1.2 ml of 100 µM DPPH (2,2-diphenil-1-picrylhydrazil) ethanolic solution was added to 0.2 ml diluted sample and this mixture was incubated in the dark at room temperature for 30 min. In the control ethanol was added instead of the sample. After 30 min the changes in colour (from violet to yellow) were measured at 517 nm. Antioxidant activity was calculated by the following equation: DPPH• scavenging effect (%) = $((A_c - A_s)/A_c) \times 100$,
where: A_c was the absorbance of the control and A_s the absorbance of the apple sample.

Ferric reducing antioxidant power assay (FRAP)

FRAP solution contained 80 ml of 300 mM acetate buffer (pH 3.6); 8 ml of 10 mM 2,4,6-Tri(2-pyridyl)-s-triazine (TPTZ; Sigma-Aldrich, Germany) diluted in 40 mM hydrochloric acid; 8 ml of 20 mM iron(III) chloride and 4.8 ml of distilled water. In the reaction mixture 4 ml FRAP reagent was added to 120 µl 5-fold diluted sample. This mixture was incubated at 37 °C for 30 min and then absorbance was measured at 593 nm. Calibration was made using 1 mM iron(II) sulfate solution in the concentration range of 0.1-1.0 mM. The FRAP of the extracts was expressed as µM Fe(II)/g lyophilized apple.

RESULTS AND DISCUSSION

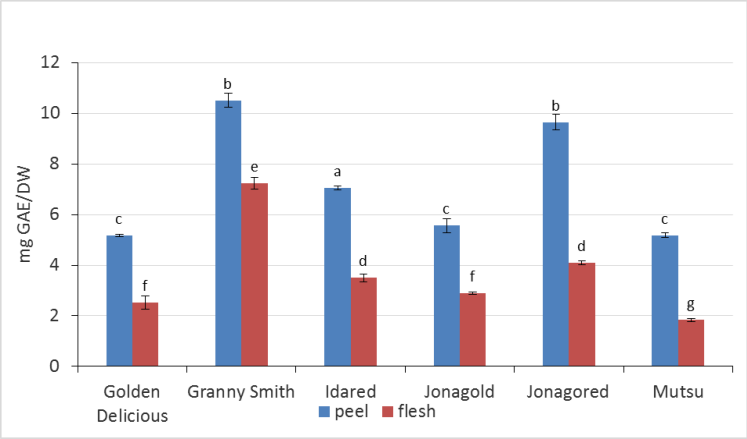

Figure 1. Total polyphenol content in the peel and flesh of the investigated apple cultivars. Different small letters represent significant differences ($p<0.05$)

Total polyphenols have been found in the highest amount in the peel of the Granny Smith cultivar, followed by the peel of Jonagored (*Figure 1*).
In general polyphenolics in peels were represented in half to twice higher amount, than in the flesh. WOLFE AND CO-WORKERS (2003) found also that some apple peels contain from two to six times more phenolic compounds, and two to three times more flavonoids in the peels than in the flesh. Because of the skin is the first defense line in the fruits it is not surprising that polyphenols with antioxidant and antimicrobial activity are concentrated here. According to HUBER AND RUPASINGHE (2009) some compounds like catechin, procyanidin, epi-catechin, and phloridzin are in much lower concentrations in the flesh than in the peels. Quercetin conjugates were found exclusively in the peel of the apples (BOYER AND LIU, 2004). Similar to the polyphenol content antioxidant activity (FRAP) was also highest in the peel of Granny Smith cultivar, followed by the peel of Jonagored (*Figure 2*).

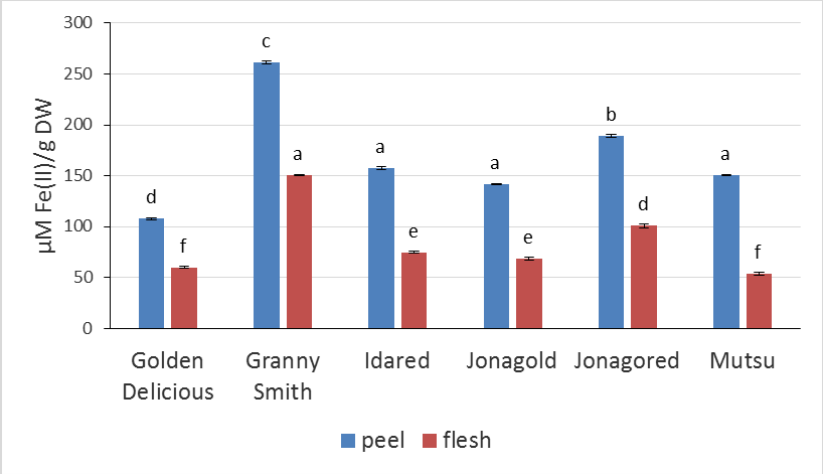

Figure 2. Ferric reducing power (FRAP) in the peel and flesh of the investigated apple cultivars. Different small letters represent significant differences (p<0.0.5)

In spite of this the radical scavenging activity seems not to depend on the polyphenol content and showed also limited correlation with the type of cultivar, but strong correlation with from what part of the fruit, peel or flesh, was the sample taken (*Figure 3*). In this case the radical scavenging activity was much higher in the peel than in the flesh.

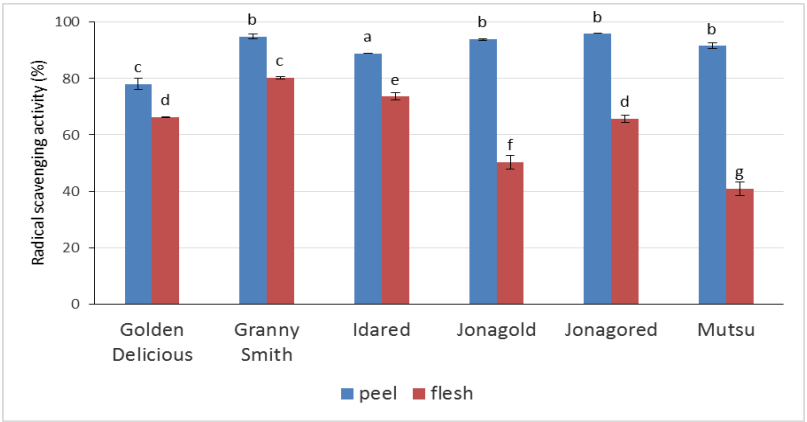

Figure 3. Radical scavenging activity (%) in the peel and flesh of the investigated apple cultivars. Different small letters represent significant differences (p<0.0.5)

Ferric reducing antioxidant power was also higher in the peels compared to the flesh of the apples. The antioxidant activity was also much greater in the peels when compared to the flesh, depending on the variety of the apple. There was a good linear correlation between the polyphenol content and FRAP, but a weak, non-linear correlation between polyphenol content and radical scavenging activity in the case of the peels, and a stronger, non-linear correlation in the case of flesh (*Figure 4*).

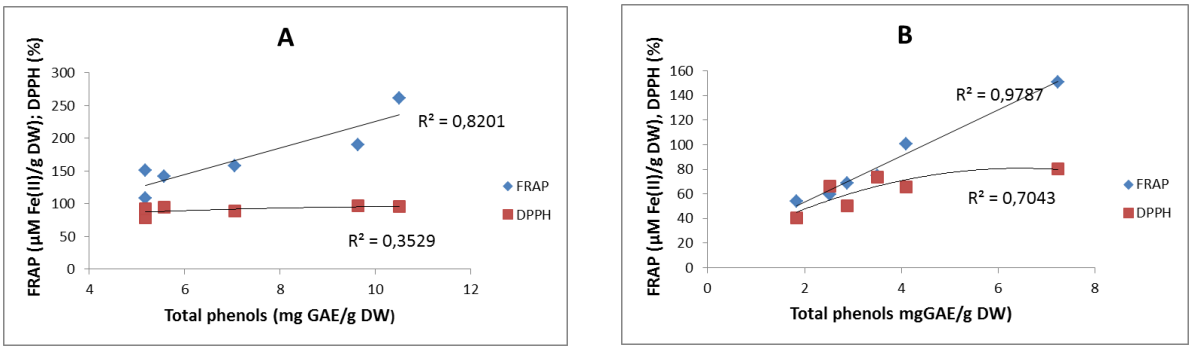

Figure 4. Correlation between total phenol content and ferric reducing power, and radical scavenging activity in the peel (A) and flesh (B) of the investigated apple cultivars.

CONCLUSIONS

The polyphenol content and antioxidant capacity differed significantly among the different apple cultivars and the green-coloured Granny Smiths proved to be the best. In all cases, peels had much higher amount of phenolics and greater antioxidant activity than the flesh, showing that apple peel is a valuable part of the fruit.

ACKNOWLEDGEMENTS

The research was supported by the NTP-HHTDK-17-0004 grant.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

ANALYSIS OF TROPHY PARAMETERS IN FALLOW DEER (*DAMA DAMA*) IN HUNGARY, 1998-2016

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ABSTRACT
The assessment of the trophy quality in Fallow deer (*Dama dama*) is often based on the measured values of the individuals with the largest antlers. However, there is little knowledge about the reliability and representativity of this approach.
In our study, we analysed the trend of the annual number of evaluated trophies between 1998 and 2016, the age distribution of the harvested bucks, and the temporal variation in the values of trophy weight and antler length during the study period on the population level and in the case of the best quality antlers. The data were examined in 3 estimated age classes (young: up to 4 yrs, middle-aged: 5-9 yrs, old: from 10 yrs). The groups (year × age class) were characterized by the median, while the largest values were picked in each group by selecting the lowest value among the individuals belonging to the upper 1%, 5% and 10% of the sample size.
The annual number of the presented trophies increased from 894 to 3,795 with an exponential trend. The proportion of the age classes changed significantly. The proportion of the young bucks increased by 10.2%, while the proportion of the middle-aged individuals decreased by 9.9%.
The median of the weight showed no trend in the complete dataset. In the young age class, it increased until 2006, then decreased until 2016. In case of the middle-aged and old individuals, the median and the strongest values at each threshold also increased. The median of the complete dataset, as well as the middle-aged and old bucks, stagnated in the case of antler length. It showed an 8.5 cm decrease between 2007 and 2016 in the young age class. In general, the difference between the group median and the largest values showed the highest variability in case of the 1% threshold. We found a strong correlation between the group median and the strongest values only in two cases (Top 10% and 5% threshold, trophy weight of middle-aged bucks).
Our results suggest that in Fallow deer, the assessment of the trophy quality based on only the largest antlers may be misleading in several cases, especially in the young age class or if the complete dataset is treated as one group. However, the trend of the largest trophy weight in the middle-aged and old age classes may refer to the trend of the median in the relevant groups.

Keywords: Fallow deer, *Dama dama*, trophy evaluation, antler, Hungary

INTRODUCTION

Fallow deer (*Dama dama*) is an introduced species in the Carpathian Basin, with multiple theories regarding the time of introduction (NAGY, 1985). Nowadays, trophy hunting is considered one of the most important aspects of big game conservation and management, and trophy hunting of Fallow deer provides a remarkable income source for many game managers locally (CSÁNYI AND LEHOCZKI, 2010). Furthermore, specific antler parameters in Cervids can be used as bioindicators of the populations (GRANT, 1979; CLUTTON-BROCK *ET AL.*, 1985; DEMARAIS AND STRICKLAND, 2011). Therefore, it is essential to examine the trends of the antler size and quality in the species in question. Assessment of the trophy quality is often based on the measured values of the individuals with the strongest (e.g., heaviest, longest) antlers. However, there is little knowledge about the reliability and representativity of this approach.
In the present study, we used the weight (24 hrs weight) of the Fallow deer trophies and the antler length (mean of main beam length on the two sides of the antlers), as these had been measured on each buck, regardless of being a medal candidate or not. We have analysed

the trend of the annual number of evaluated trophies between 1998 and 2016. We have examined also the age distribution of the harvested bucks and the temporal variation in the values of trophy weight and main beam length during the study period on the population level and in the case of the shot bucks with the best quality antlers.

MATERIAL AND METHOD

In Hungary, it is compulsory to present each antler for evaluation and scoring (Act LV., 1996: Act on Game Conservation, Management, and Hunting). The long-term datasets collected by the hunting authority are stored in the National Game Management Database (CSÁNYI ET AL., 2010). The 24 hrs weight is calculated by software used by the hunting authority and refers to a weight that could have been measured on the trophy 24 hours after its preparation (CSÁNYI ET AL., 2006). This calculation makes it possible to compare the measured weights. The main beam length is measured from the lower edge of the coronet, on the outer curve and along the longitudinal axis of the antler, up to the highest point of the closed palm (INTERNATIONAL COUNCIL FOR GAME AND WILDLIFE CONSERVATION, 2014). The weight is decisive regarding the price of the hunt, furthermore, both parameters are included in the trophy evaluation formula of the International Council for Game and Wildlife Conservation (CIC); thus they affect the final score and medal category of the trophies. The age is estimated by the administrators of the hunting authority, based on primarily the thickness and angle of the pedicles, and the tooth wear of the upper jaw.

The trend of the annual number of the evaluated trophies was analysed through Pearson-correlation, and χ^2-test was performed to examine the changes in the estimated age class proportion. The measured values were examined in 3 estimated age classes (young: up to 4 yrs, middle-aged: 5-9 yrs, old: from 10 yrs). As distributions of annual data differed from the normal distribution in most cases (Shapiro-Wilk test), the groups (year × age class) were characterized by the median. The largest values were picked in each group by selecting the lowest value among the individuals belonging to the upper 1%, 5% and 10% of the sample size. The relationship between the group medians and the lowest values among the individuals belonging to the upper portion of the groups was examined with Pearson-correlation.

We used Corel Paradox 11 (Corel Corp.) software and Kutools for Excel (ExtendOffice) for the database operations, and Past 3.14 (HAMMER ET AL., 2001) for the statistical analysis.

RESULTS

The annual number of the presented trophies (n=42,059) increased from 894 to 3,795 with an exponential trend ($\log_{10}$; Pearson-correlation, r=0.97, $P<0.001$). During the study period, the number of the shot Fallow bucks – and therefore the evaluated trophies – approximately quadrupled in each age class. The highest increase rate can be observed in the case of young individuals (*Figure 1*).

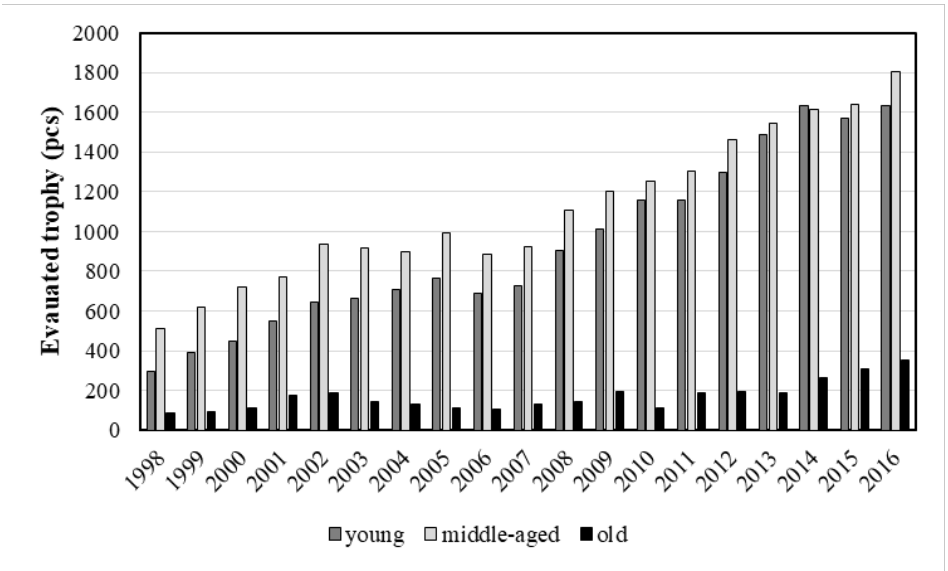

Figure 1. Annual number of the evaluated Fallow deer trophies belonging to each estimated age class in Hungary (1998-2016)

The distribution of the age classes changed significantly (χ^2_{36}=342.25, P<0.001). The proportion of the young bucks increased from 32.8% to 43.0%, while the proportion of the middle-aged individuals decreased from 57.5% to 47.6%. Meanwhile, the proportion of the trophies from old Fallow deer varied between 4.7% and 11.7% (started at 9.7% and returned to 9.4%), as shown in *Figure 2*.

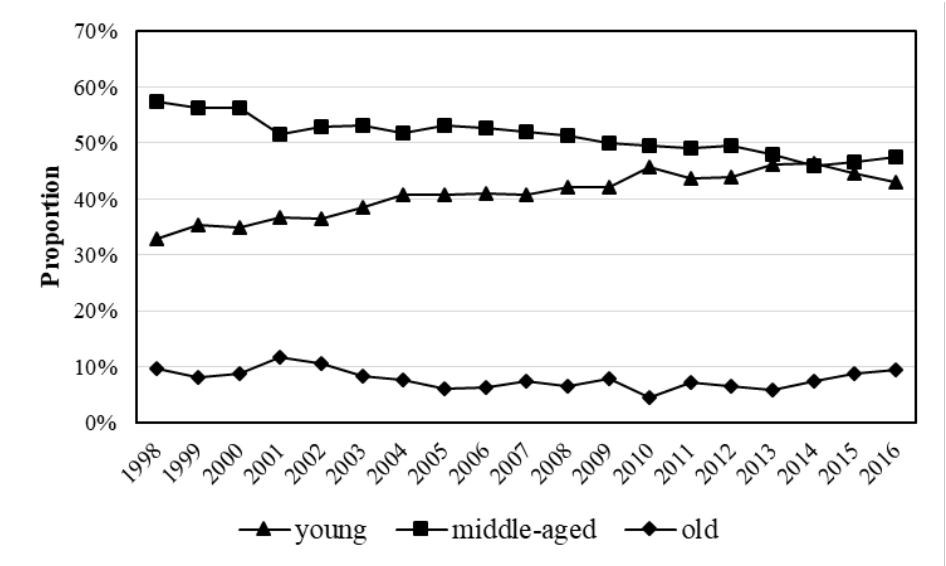

Figure 2. Proportion of the estimated age classes of the Fallow deer trophies (1998-2016)

The median of the weight showed no trend during the study period in the complete dataset (*Figure 3*). In the young age class, this value increased by 0.35 kg until 2006, then decreased by 0.39 kg until 2016. Meanwhile, an increase occurred in case of the middle-aged and old individuals (from 2.9 kg to 3.3 kg and from 3.4 to 4.1, respectively). In these two age classes, the strongest values also increased in case of each threshold: between the data from 1998 and 2016, the largest difference was 1.08 kg (old age class, Top 1%), while the smallest difference was 0.57 kg (middle-aged bucks, Top 5%, and 10%).

The variability in the values of the heaviest antlers was the highest at the Top 1% and the lowest at the Top 10% threshold in each group, as well as in the complete dataset.

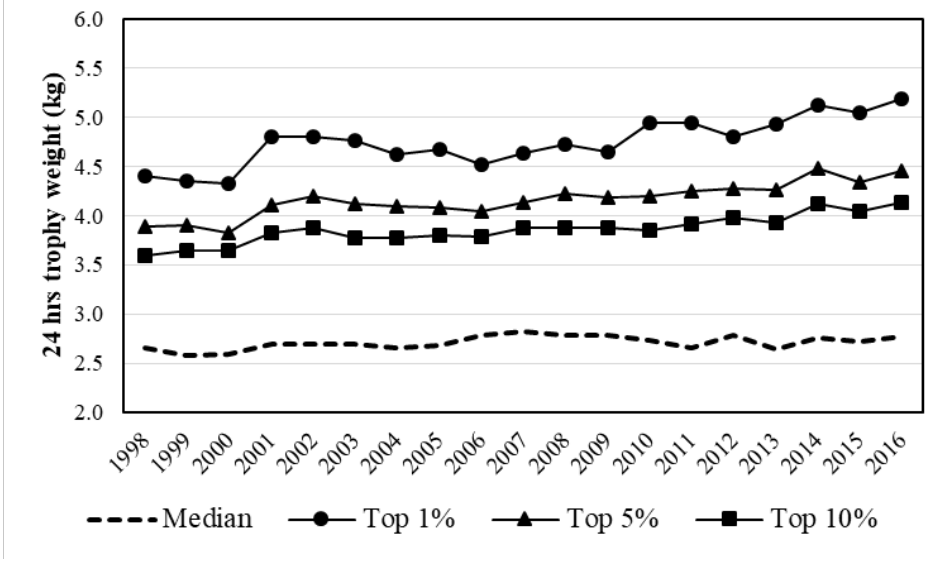

Figure 3. Median and top values of the trophy weight (1998-2016)

Despite the changes in the amount of harvested individuals – with 2.8 cm maximum-minimum difference – the median of the complete dataset proved to be stable in the case of antler length (*Figure 4*). Similarly, the median stagnated also in case of the middle-aged and old bucks. At the same time, the median varied between 35.9 cm and 48.3 cm and showed an 8.5 cm decrease between 2007 and 2016 in the young age class.

The values of the longest antlers showed the highest variability at the Top 1% threshold in each group, as well as in the complete dataset. However, no clear trend can be observed by the best values of the antler length in any group or the complete dataset (*Figure 4*).

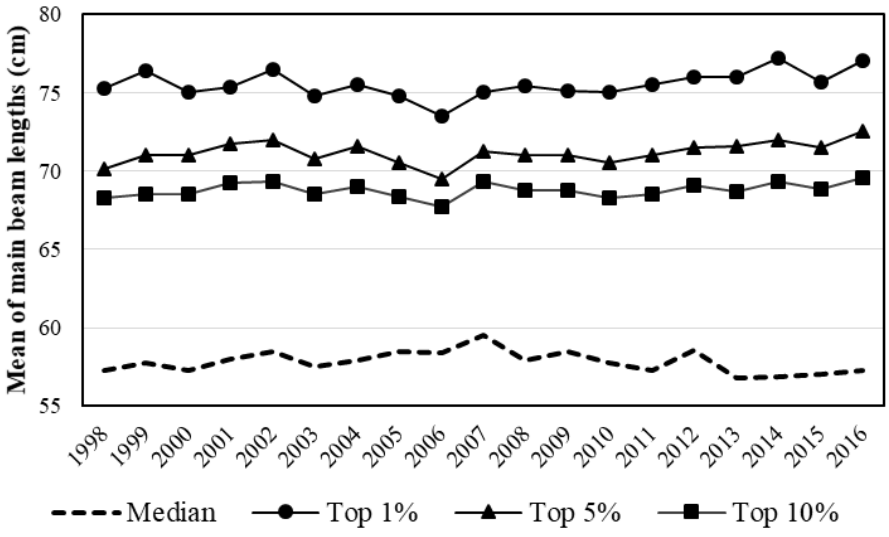

Figure 4. Median and top values of the main beam length (1998-2016)

As represented by *Table 1*, we found a strong correlation between the group median and the lowest value among the individuals belonging to the upper portion of the group only in two cases (Top 10% and 5% threshold, trophy weight of middle-aged bucks). In the case of antler length, no relationship could be found at the Top 1% in any group, furthermore at

any threshold in the complete dataset. At this parameter, the highest R-value was 0.73 (Top 10%, middle-aged bucks).

Table 1. Pearson-correlation between the group median and the lowest value among the individuals belonging to the upper portion of the group (*P<0.05; **P<0.01; ***P<0.001)

Parameter	Group	Top 1%	Top 5%	Top 10%
24 hrs trophy weight	Young	NS	NS	0.51*
	Middle-aged	0.79***	0.94***	0.98***
	Old	0.53*	0.79***	0.82***
	Complete dataset	NS	0.57*	0.59**
Mean of main beam lengths	Young	NS	NS	0.52*
	Middle-aged	NS	0.46*	0.73***
	Old	NS	0.58**	0.52*
	Complete dataset	NS	NS	NS

CONCLUSIONS

In Hungary, the increasing estimated population size of the big game species is typical (CSÁNYI ET AL., 2017), which can be explained mainly by the growth of the forested areas or other suitable habitats (LINNELL AND ZACHOS, 2011). The level of hunting pressure may also affect the population trends (KENWARD AND PUTMAN, 2011), as well as the antler parameters (RIVRUD ET AL., 2013). As the harvest data can be an index of the population trends (FORCHHAMMER ET AL., 1998 and references therein), the two values are connected; consequently, the increasing number of the evaluated Fallow deer trophies (which equals to the hunting bag of the bucks) was expectable.

Due to the changes in the structure and size of the antlers that Cervids develop year by year, – beside the genetic potential and the environment – the age itself affects the antler parameters at some level (DEMARAIS AND STRICKLAND, 2011). Beyond this fact, the result of our analysis on the age distribution also confirmed that the age classes should be treated separately when the trophy quality of the Fallow deer population is assessed.

In Hungary, the species is partially managed in enclosures, which could cause the growth in the best values of the trophy weight. On the other hand, the similar growth in the group median of the middle-aged and old individuals does not support this theory, as only a minor proportion (13.0% in the 2016/2017 hunting year) of the harvested bucks originates from hunting parks (CSÁNYI ET AL., 2017).

According to the legislation of hunting in Hungary, a restriction system protects the young and middle-aged bucks with antlers that meet specific criteria and probably will be able to develop stronger antlers in the following years. The increase in the median and the best values of the trophy weight of the middle-aged and old individuals may indicate the potential efficiency of the management. The decline in weight median of the young age class during the last ten years of the study period may also suggest that the selection of the hunters tends to follow the antler restriction system.

On the other hand, the top values of trophy weight or antler length and the median of the given age class did not follow the same trend and showed no correlation in several cases, which resulted in the variability of the difference between the group median and the largest values. In general, the difference between the group median and the largest values showed the highest variability in case of the 1% threshold.

In summary, our results suggest that in Fallow deer, the assessment of the trophy quality

based on only the largest trophies may be misleading in several cases, especially in the young age class or if the complete dataset is treated as one group. However, the trend of the largest trophy weight in the middle-aged and old age classes may refer to the trend of the median in the relevant groups.

ACKNOWLEDGEMENTS

This work was supported by the ÚNKP-17-3 New National Excellence Program of the Ministry of Human Capacities (ÚNKP-17-3-I/SZIE-36 - Analysis of spatial and temporal trends in certain trophy parameters of big game species in Hungary - I.K.). The publication is supported by the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund (G.S. and S.Cs.).

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

PRODUCTION OF TOMATO CAROTENOIDS (*SOLANUM LYCOPERSICON* MILL.) DURING DIFFERENT FORCING PERIODS

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ABSTRACT
Tomatos are one of the most widely grown and consumed vegetables in the world. It does not only meet the needs of the fresh market, but also has become an essential ingredient for the food industry. Since 2012, however, intensive soilless forcing is gaining ground on increasingly large areas, using more and more modern technologies. This will make the fulfilling of our domestic tomato demands more continuous, however we can also produce for exports.
However, the yield is not all! Continuous forcing also means that the plant grows during the winter-spring period when biological and other physical factors are not in line with nature. During this period, the necessary factors must be artificially provided for the plant! There may be a question as to what kind of quality differences can be found between autumn-winter and spring-summer tomatoes?! The most valuable carotene of the tomato is the red lycopene, which is continuously produced during ripening. However, elevated air temperatures above 32 °C can stop the production of lycopene and then the yellow ß-carotene becomes a stronger colour in the berry. During my work, I studied the ratio of the production of the two carotenoids in different types in different forcing periods.

Keywords: tomato, lycopene, β-carotene, all carotene substances

INTRODUCTION

Tomato belongs to the family of Solanaceae and to the genus Lycopersicon. Lycopersicon is made up of two main subgenera. The basis of the classification was initially the colour of tomato. The green crops are Eriopersicon, and the coloured (red, yellow) crops are in Eulycopersicon (MÜLLER, 1940). RICK (1976) grouped the species into how easy or difficult it is to cross the cultivated tomato species. Its fruit is called berries. Its shape is varied: from the flat round to the plum- and the pear-shaped, all the intermediate shapes can occur. The colour of the berry is given by the shell and the flesh. The tomato with colorless skin and yellow flesh is yellow, the one with colorless skin and red flesh is red, while the one with yellow skin and red flesh is red (LOCAL, 1999). The red colour of the fruit is due to the lycopene produced continuously. Lycopene ($C_{40}H_{56}$) is an open-chain compound, strong antioxidant. It can also be made from petrol-ether in the form of red needle crystals. It can be typically found in the berry of tomatoes, and in the flowers, roots, seeds and fruits of higher-order plants (SZEKERES ET AL., 1967; GASZTONYI ET AL., 1992). During the processing of the tomato and during its ripening, above 26 °C berry temperature, the production of lycopene stops and it becomes β-carotene (ISHIDA, 1990). Beta-carotene is also a bicyclic, yellowish compound. It has the same formula as α-carotene. It is converted into vitamin A in the body. The transformation occurs in the liver by the action of the carotinase enzyme (SZEKERES ET AL, 1967). The β-carotene is the most prominent member of the group of carotenoids, natural colorants that occur in the human diet (BRITTON ET AL., 2008). As a tetraterpenoid it consists of 40 carbon atoms in a core structure of conjugated double bonds substituted with 2 β-ionone rings. Due to its extended system of 9 fully conjugated double bonds, β-carotene shows a major absorption peak in the visible spectrum with a maximum at ~450 nm, responsible for the orange to red color of the compound (BRITTON ET AL., 1995). Lycopene is a lipophilic, unsaturated carotenoid,

found in red-colored fruits and vegetables, including tomatoes, watermelon, papaya, red grapefruits, and guava. The main activity profile of lycopene includes antiatherosclerotic, antioxidant, anti-inflammatory, antihypertensive, antiplatelet, anti-apoptotic, and protective endothelial effects, the ability to improve the metabolic profile, and reduce arterial stiffness (MOZOS ET AL., 2018). The color of lycopene is directly related to its isomeric form. The all-trans isomer and most other isomers of lycopene are red, whereas tetra-cis-lycopene possesses an orange hue (ZECHMEISTER, 1944).
Both carotenoids are very important for humna body, but the market favours lycopene-rich red tomatoes. Due to the yellow colour of the berry, a potassium deficiency is often suspected during propagation, but the cause of this phenomenon is actually the elevated temperature.
To address this topic, we have set the following aims:

- Detection of the two most important carotenes of tomato production, lycopene and β-carotene, with HPLC methods.
- Analysis of changes in carotenoid varieties of harvested types in the context of the forcing periods and the total carotene production.

MATERIAL AND METHOD

Harvesting of tomato berries was carried out at the greenhouse plant of Floratom Kft. in Szeged. In the greenhouses, the intensive cultivation of different types of tomatoes is carried out on coir, applying thermal water heating. We collected 3-3 berries from three different types of varieties during the picking period. In March 2017 we studied the tomatoes collected from the winter and spring period, and the berries collected from the summer-and-autumn period were studied in November 2017. Our laboratory tests were carried out by HPLC instrumental examination in the special carotene laboratory of the Pharmacognosy Institute of the University of Pécs.

The examined tomato genotypes:

- Quentero F_1: medium-mature, with a berry-weight of 130-150 g, round-shaped, with a vivid red skin
- Direktion F_1: intense, plum-shaped, vibrant red-coated, continuous growth
- Ardiles F_1: intensive ripening, soft berry 35-40 g, mini plum shaped, deep red colored

The most important work phases of the laboratory detection methodology:

- drying of the examined tomato berries at 60 ° C, separately for each genotype,
- measurement and egalitization,
- storage in dry place,
- solving in acetone (24 hours),
- filtration, sedimentation,
- soaking in dimethyl ether,
- separation of fractions with dimethyl ester,
- vacuum distillation,
- another dissolution in ether,
- KOH saponification,
- instrument definition of carotenes HPCL.

RESULTS

On the basis of the instrumental tests, the lycopene and β-carotene concentrations of the berries of the harvested tomatoes were determined. The HPLC chromatographic diagrams show the presence of several carotenoids, of which only the results of the two mentioned carotenoids (lycopene and β-carotene) have been considered (*Figures 1,2* and *3*). *Table 1* and *Table 2* show the average values of berry lycopene, β-carotene and total carotene content measured in 3 replicates.

Regardless of seasons, the lycopene was present in very high concentrations in all cultivated tomatoes, although at different concentrations per variety. The least amount of lycopene was in the winter-spring forced Direktor F_1 tomato. The highest amount of it was in the winter-spring forced Ardiles F_1 berries. In tomato berries from summer-autumn, there was a high variation between β-carotene percentages. Ardiles showed a deviation of 4.75%, Direktion 8.98% deviation, and the largest difference was in the Quentero F_1 tomato with 19.91%.

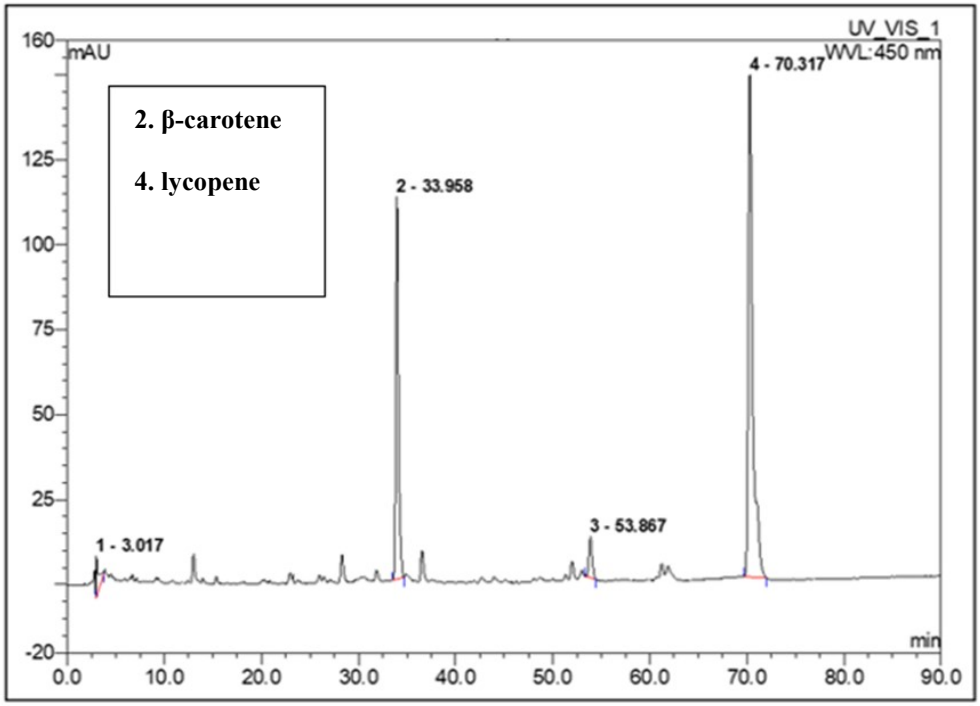

Figure 1. The instrumental test result of Direktion F1 tomato berries

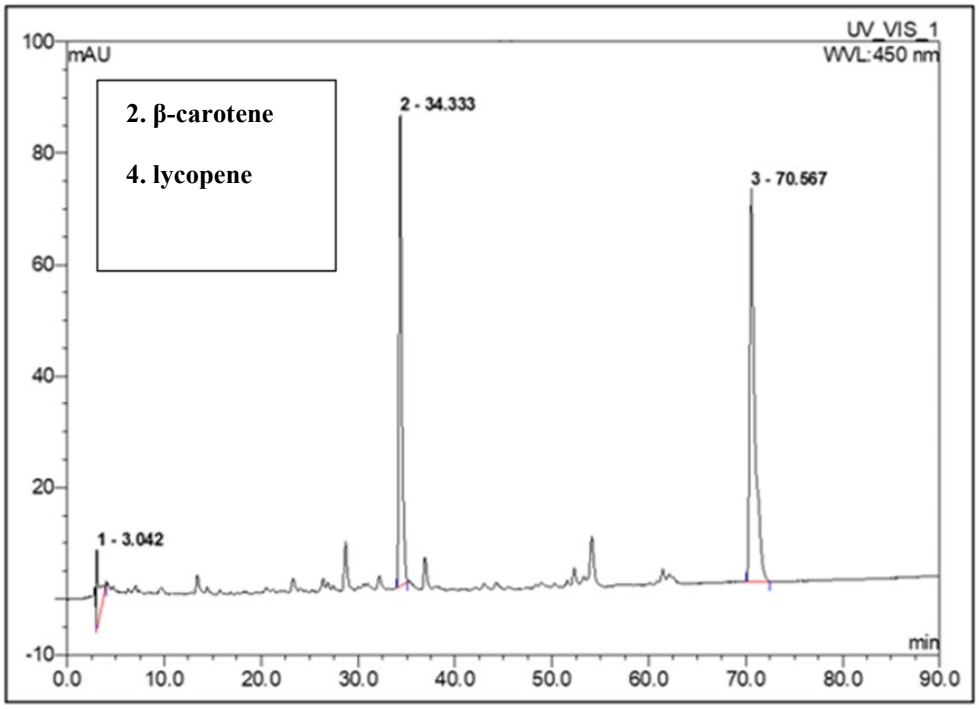

Figure 2. The instrumental test result of Quentero F1 tomato berries

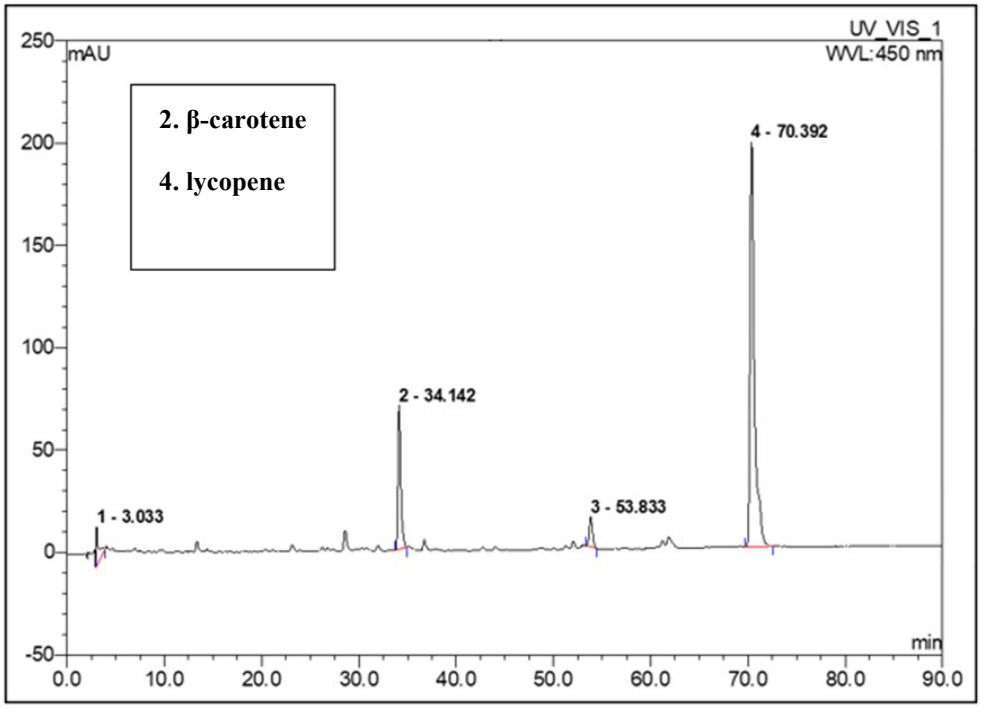

Figure 3. The test result of Ardiles tomato berries

CONCLUSIONS

A number of studies have suggested that certain factors influence the efficiency of β-carotene absorption and/or conversion to retinol. Several scientific reports have indicated a negative relationship between β-carotene status and type 2 diabetes. Although the FDA concluded that there is "no credible evidence to support an association between lycopene intake and a reduced risk of prostate, lung, colorectal, gastric, breast, ovarian, endometrial or pancreatic cancer," based on the results of our work, we can recommend tomatoes from winter-spring forcing for more intensive utilization because human body can get more lycopene and more antioxidants of carotene origin.

ACKNOWLEDGEMENTS

We would like to thank the Floratom horticulturists in Szeged who allowed us to gather tomatoes. We thank Professor József Deli for his work, his time for us, and the opportunity to carry out our studies. Thanks to Roland Lukács, who followed our work with all his patience and helped us in the practical implementation.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

INFLUENCE OF PLASTIC MULCH BETWEEN ROWS ON THE YIELD AND QUALITY OF WATERMELON (*CITRULLUS LANATUS*)

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ABSTRACT
The watermelon (*Citrullus lanatus*, THUNB. Matsum & Nakai.) is an important and valuable vegetable crop that has the 3rd largest cultivated area in open field in Hungary. Our experiment was set up in the largest and most intensive melon growing area in Hungary, at Dombegyháza in Békés County. Our investigations were carried out with the *Grizzly* watermelon variety and during the experiment 5 different colors of plastic mulch (purple, transparent, green, black, and butter coloured) were used, the control was uncovered. In the field we measured the average weight of the fruits, and during our laboratory measurements we examined the following nutritional characteristics: invert and reducing sugar content, refraction and acidity. Based on the results of the two years of our study we can state that the different color of the plastic mulch did not show significant differences in the examined quantitative and qualitative parameters. Using plastic mulch soil covering between the rows in the watermelon production is likely to continue due to the fact that the fruits remain clean, between the rows the soil remains weed-free, and the problem of labor shortage can be solved with this technology.

Keywords: watermelon, plastic mulch between rows, average, inner content

INTRODUCTION

The watermelon (*Citrullus lanatus*, THUNB. Matsum. & Nakai) is an important and valuable vegetable crop that has the 3rd largest cultivated area in open field in Hungary. In 2016 the sowing area of watermelon was 5500 ha, and ca. 220,000 tons of fruit were harvested (FRUITVEB, 2016). Melon growers face continuous challenges, one of the main problems is the lack of labory. Growers are increasingly looking for technological solutions that has the least manual labor needs. The appearance of the plastic mulch between the rows was a major step in the growing technology. The hand hoeing between the rows is unnecessary with this technology.
It should be mentioned that the purchase and the laying of the plastic mulch foil is a big investment, but it is worth applying due to its positive effects.
Weed control effect has long been known for these foils. The color and the quantity of the transmitted light specify the weed control ability of these foils. Under the transparent foils the weeds are able to proliferate but under dark foils the germination is blocked or if it is not done, they will perish quickly without light (TERBE, 1995).
The rootzone temperature is influenced positively by the mulch, because it can increase or decrease the temperature depending on the foil's color. The right soil temperature supports the develeopement of the seedlings, by making the nutrient uptake easier (DIÁZ-PÉREZ, 2012).
The covering can influence the quality and quantity of fruits. Covering may enable earlier harvest, by generating favorable conditions for the development of the plant. Earliness is influenced by the soil type and the geographical location, too. Under better quality cleaner fruits are meant, because the foil forms a blockade between the fruit and the soil (LAMONT, 1993).

The cover materials proved to be useful in the pest control, too. The rate of photosynthesis, the yield, and the appearance of useful insects and pests is also influenced by the soil covering (MURPHY ET AL., 2009; ZANIC ET AL., 2009; SIMMONS ET AL., 2010).
Those who would like to use this technique, have to count with the additional costs. But we must mention, that the usual 3-4 times of weeding a year between the rows is no longer needed, so the extra expenses are reduced, and the lack of labory is solved too (BALÁZS ET AL., 2017).
RAO ET AL. (2017) compared 6 different colored soil cower plastic mulches with the straw mulch and the uncovered rows in the case of watermelon. In this study, plastic mulches proved to be better than the straw mulch. The best plastic mulch was the silver colored foil, it produced the best yield, the least yield was measured with the uncovered rows.
DÍAZ-PEREZ (2012) experimented with plastic mulch cover in watermelon production. He compared black, blue, grey, red, gold and white foils. Plants covered with gold and white foils showed weaker development, and the most clorotic leaf's could be found between them.
The biggest yield was measured under the red plastic mulch, and the lowest under the gold one.
We are researching the negative and positive effects of the plastic mulch between the rows on the quantitative and qualitative values of the yield. Our experiment was set up in the largest and most intensive melon growing area in Hungary, at Dombegyháza in Békés County.

MATERIAL AND METHOD

Our investigations were carried out with the 'Grizzly' watermelon variety and during the experiment 5 different colored plastic mulches (purple, transparent, green, black, and butter colored) were used, the control was uncovered. The variety has beautiful colored peelings, is square shaped, and has big yield, these traits make it ideal for the home field marketing. The warm red colored mesocarp indicates great inner contents. The variety has strong vigor and good covering leaves. 'Grizzly' has an excellent fruit set and low sunscald aptitude. The well-developed and trained watermelon seedlings were planted out in 5 rows, in 2016 with 4 repetitions, and in 2017 with 3 repetitions. 35 plants per repeat were used. Between the rows there were 2.2 meters and inside the rows the distance between plants was 0.5 meter. After planting, the seedlings were covered with a low plastic tunnel. After 1-2 days - when the temperature became higher - we made some slits to provide the plants some ventilation. We removed the plastic tunnels at the end of May when blossoming began. After removal of the tunnels, we laid the plastic mulch between the rows immediately, because the watermelon can spread between the rows quickly. Before removing the low plastic tunnel, we used row cultivator. The plastic foil's width was 180 cm in both years with 0.02 mm thickness. Every plastic foil was microperforated, so the rain can flow away from the foils. The foils were laid by hand.
After harvesting the parcel, we examined the weight of the fruits using a digital libra in the field. We calculated the average weight from the measured weights.
During our laboratory measurments, we examined 2-2 watermelon per repeat in the same ripening stage. The following nutritional characteristics were investigated: invert and reducing sugar content, refraction and acidity. The measurement of the refraction was done with a hand refractometer (PAL-1, ATAGO). Our results were specified in Brix°. The sugar content was measured using the Luff-Schorl method. We used the Hungarian standard (MSZ3619-1983) to measure the acidity. For the statistical evaluation of our field

and laboratory results, IBM SPSS 23.0. statistical software package was used. Our experimental results were evaluated by two-factor analysis of variance (ANOVA) for all variables.

RESULTS

We harvested once both years, on the 25th of July in 2016, and on the 15th of July in 2017. We measured the average weight of the fruits. We could not find a big difference between the results of the two experimental years.
In 2016, the transparent colored foil gave the biggest average weight with 7.96 kg/fruit, in 2017 the heaviest fruit was gathered from the purple foil, with a weight of 8.06 kg (*Figure 1*). We observed, that the average weights were more uniform in 2016, but the statistical evaluation did not show any significant difference in the years (p=0.692), treatment levels (p=0.754) and the two-factor interference (p=0.770) in the different years.

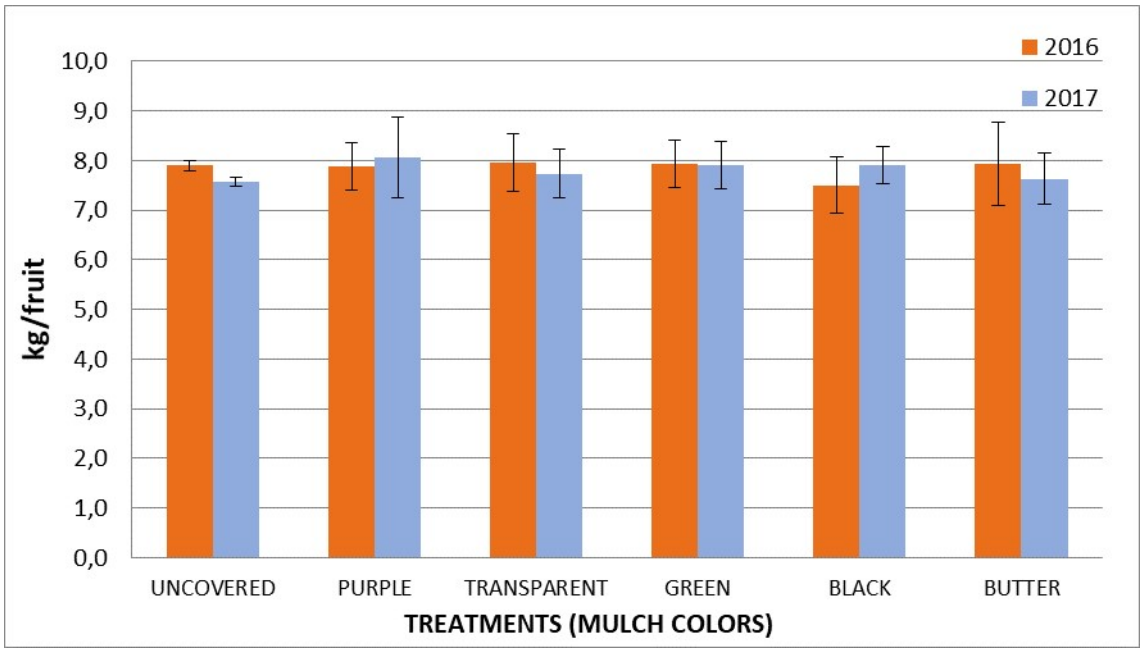

Figure 1. The effect of mulches on the average fruit weight, 2016, 2017

The acidity was between 0.08-0.1% in both years, except for the case of the purple foil mulch where we measured a value of 0.079% in 2017 (*Figure 2*). The uncovered, the purple and the transparent covers resulted higher acidity in 2016. In the case of the green foil, the results of both years were even, and in the case of the black and butter colored plastic mulches the results were higher in 2017. The statistical evaluation did not show any significant difference in the years (p=0.699), the treatment levels (p=0.563) and in the two-factor interference (p=0.340).

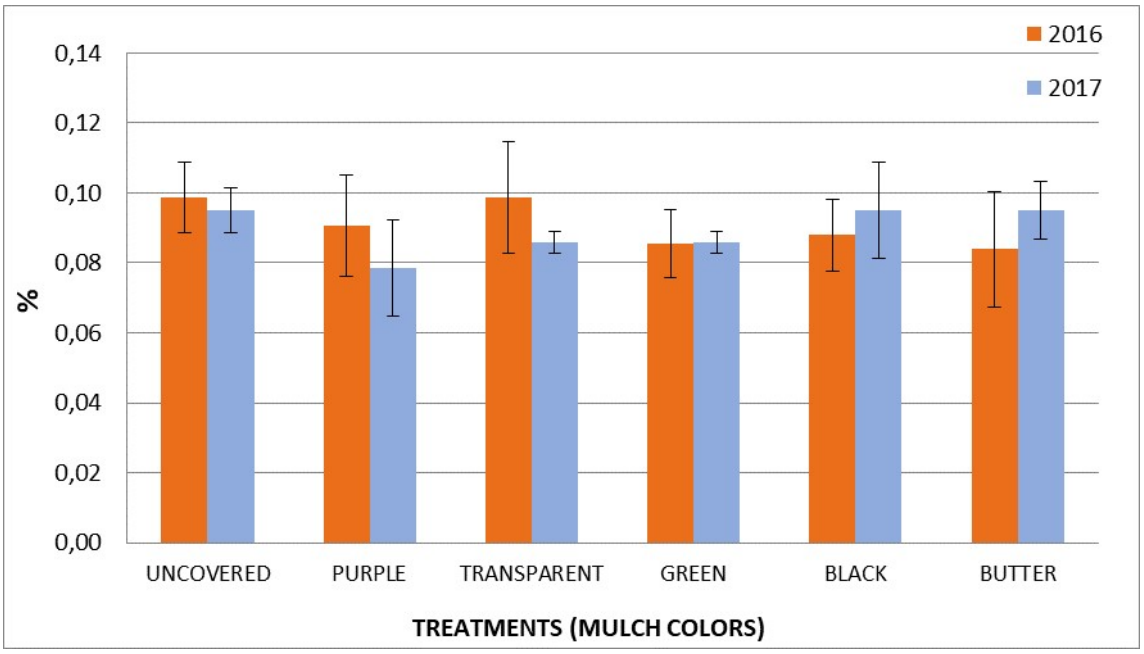

Figure 2. The effect of mulches onto acidity, 2016, 2017

To make the illustration easier, we display the reducing, invert sugar content and refraction results of 2016 (*Figure 3*), and 2017 (*Figure 4*) on separate figures.
In 2016, the highest refraction average value was under the purple foil, with 11.08 Brix° (*Figure 3*), in 2017 11.34 Brix° was the highest, under the transparent foil. We can observe higher refraction levels among the treatments of 2017 compared to 2016, expect for the purple and black foil covers, these resulted in the same average values in both years (*Figure 4*). The lowest refraction level was found under the uncovered and the green foil in 2016, and under the purple in 2017. We could not find significant differences in the years ($p=0.106$), the treatment levels ($p=0.805$), and neither in the two factor interference ($p=0.333$).

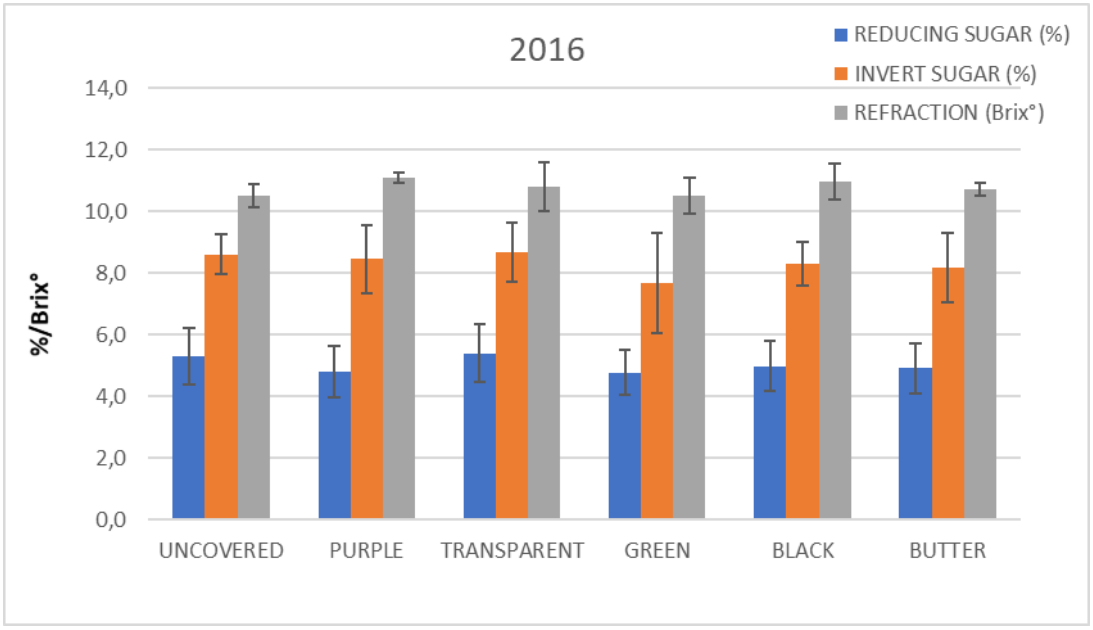

Figure 3. The effect of mulches onto reducing- and invert sugar content and refraction, 2016

We measured the levels of some carbohydrates: glucose, fructose, and sacharose. Glucose and fructose are reducing sugars, sacharose belongs to not-reducing sugars. In 2016, the sugar contents are roughly uniform, we could not find any outstanding values. In both years, the reducing sugar contents were between 4-6%, and all the invert sugar contents were over 8%, expect for the green foil cover in 2016 and the purple cover in 2017 (*Figure 4*). In the case of the reducing sugar content, we found significant difference between the years (p=0.039), but the treatment levels (p=0.774) and the two-factor interference (p=0.460) did not show any significant difference. In the case of the invert sugar content, there were no significant differences in the years (p=0.637), the treatment levels (p=0.861) and the two-factor interference (p=0.127)

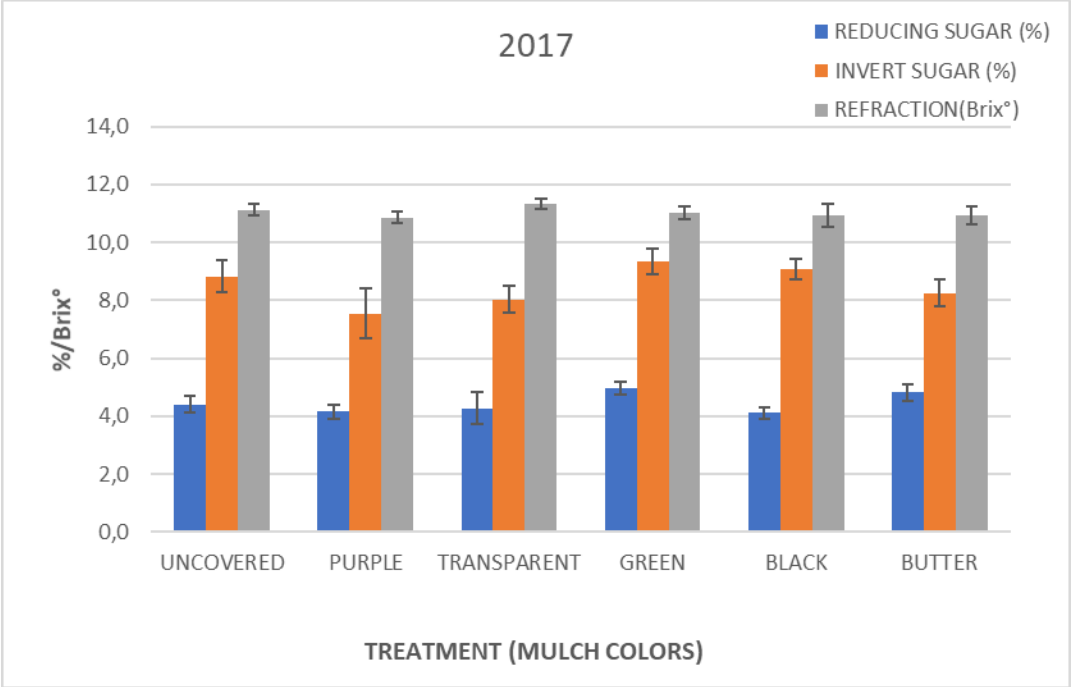

Figure 4. The effect of mulches onto reducing- and invert sugar content and refraction, 2017

CONCLUSIONS

While investigating earliness, we found that the soil covering between rows does not affect the parameter under consideration, which is contrary to LAMONT'S (1993) results that stated that covering would have an effect on the harvest time. None of our experimental years showed any differences in the ripening of the fruits undergoing the different treatments.
DÍAZ-PÉREZ (2012) also came to a similar conclusion that the different colored plastic mulches do influence the average yield, but the difference between the average yields of the plants cultivated on the different colored mulches was not significant. According to our calculations, we concluded that the average weight of the fruits was not affected by the different colored plastic mulches. Refraction measurement proved that mulching and different color plastic mulches do not affect the refraction values. This parameter did not show any vintage effect either.

Regarding the content of carbohydrates, it was found that mulching and the color of the covering did not change the reducing and inverted sugar content of watermelon. The study concluded that there is a minimum correlation between refraction and sugar content.
Concerning the acidity, we concluded that only in the case of the green foil mulch were the values equilibrated (equally low) but in general, the mulching and the color of the plastic did not affect the acidity.
We concluded that in the case of any color the films had a good weed control ability, and our harvested crops were cleaner, too, so it is worth to use covering. According to these foundings TERBE's (1995) statements can be confirmed and supported.

ACKNOWLEDGEMENTS

Supported by the ÚNKP-17-2 New National Excellence Program of the Ministry of Human Capacities.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

ADVANTAGEOUS TRAITS OF HUNGARIAN TOMATO ACCESSIONS FOR FUTURE UTILIZATION

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ABSTRACT
Due to its production and consumption volume, tomato is one of the most important vegetable of the World. Extensive efforts have been made to overcome genotypic difficulties that decelerated gradual increase of yield. Throughout this improvement, plant genetic resources (PGRs) with unfavorable vegetative and generative characteristics together with possibly valuable traits (e.g. rich flavor, outstanding nutritional content, uncommon fruit size, color, and shape, high adaptation to environmental extremities) have been lost. The side-effects of modern breeding progress, such as loss of flavor, lower nutritional content are measurable now in modern varieties. Tomato PGRs collected by gene banks are available for screening and for re-use of advantageous genes; for this, accession-level testing has to be executed.
The hypothesis of the present study was that the selected Hungarian tomato accessions have valuable yield characteristics, which can be utilized in future breeding programs.
In a three year (2012-2014) open field trial, four PGRs with pepper-shaped fruits were grown together with San Marzano variety as a reference point. The PGRs were the followings (place of origin in brackets): RCAT030271 (Kozárd), RCAT031255 (Soltvadkert), RCAT031257 (Gyöngyös), and RCAT060349 (Nagykáta). The location was the certified organic land of SZIE Soroksár Experimental and Educational Station, Hungary. The propagation material was provided by Research Centre for Agrobiodiversity (NöDiK), Tápiószele. Weight of weekly yield was measured; the fruits were separated to three fractions, i.e. intact, cracked, and infected fractions. Coherences with weather parameters were also investigated.
The potential yield (summary of all fractions) of PGRs were comparable with that of San Marzano variety in 2012, however, the cracked fraction of PGRs were significantly higher. The arid weather of 2013 reduced the ratio of cracked fractions in the case of all PGRs and the variety. The extremely humid season of 2014 was favorable especially for RCAT031257, the intact fraction of which was significantly higher than those of San Marzano. The potential yield of PGRs, with the exception of RCAT060349, was two-fold higher than the value of San Marzano. It was concluded, that scanning Hungarian tomato PGRs for useful traits (e.g. high yield in weather extremities, novel fruit color and shape) is reasonable; these characteristics can possibly be utilized by future breeding efforts.

Keywords: landrace, plant genetic resources, marketable yield, abiotic disorders, breeding

INTRODUCTION

„The plants of the old times – in contrast with the varieties of today which are often genetically overbred and produced in monocultures (…) – has been adapted to the environment that they together formed an organic unit" (ÁNGYÁN ET AL., 2003). Landraces can be characterized by a lower yield (MANSHOLT, 1909; ÁNGYÁN et al., 2003) and a higher fruit quality (ÁNGYÁN ET AL, 2003; GYULAI AND LAKI, 2005). These plant genetic resources (PGRs) are the elements of the extensive systems (ÁNGYÁN ET AL., 2003). According to ZEVEN (1998), landraces were produced over hundreds of years due to their high yield safety; new varieties were bred for high yield in an intensive agricultural system. The yield safety of landraces is provided by the genetic diversity of the given population – certain genotypes are unable to tolerate the environmental factors, while other

can survive. For this reason, landraces are produced all over the World, and this is the characteristic, which provided food for humankind over 10,000 years.
Popularity of traditional tomato types show a constant increase; consumers believe, that certain fruit characteristics, like ribbing, or odd shapes, correspond to better organoleptic content (TIGCHELAAR, 1986; MALE, 1999; CASALS ET AL., 2011; GARCIA-MARTÍNEZ, 2012). With the use of landraces, market diversification and satisfaction of consumer expectations can be executed. Furthermore, certain PGRs can fill market niches of special processing aims (ERTSEYNÉ PEREGI, 2011).
Like in the past and present, heterogeneous landrace populations can serve as important breeding materials in the future (ZEVEN, 1998; MÁRAI, 2010), therefore the maintenance of these phenotypes is an ongoing task. For the utilization of PGRs, the identification of the accession characteristics is inevitable, with special regards to genotypic and phenotypic ones (MAZZUCATO ET AL, 2010, TERZOPOULOS AND BEBELI, 2010).

MATERIAL AND METHOD

The characteristics of the selected four accessions are shown in *Table 1*. The propagation material was provided by Plant Biodiversity Center, Tápiószele. San Marzano variety was used as the control variety of the experiment, the fruits of which are elongated with blunt tip and narrow shoulder.

Table 1. RCAT code, origin and fruit characteristics of Hungarian tomato accessions selected for yield investigation

RCAT number	Origin	Year of acquisition	Fruit shape*	Fruit color
RCAT030271	Kozárd	1976	elongated	red
RCAT031255	Soltvadkert	1976	elongated	red
RCAT031257	Gyöngyös	1977	elongated	red
RCAT060349	Nagykáta	2006	elongated	red

*According to UPOV TG 44/11 Tomato Descriptor

The experiment was run between 2012-2014 on the organic certified lands of SZIE Experimental and Educational Field, Department of Organic Farming. Seed sowing and seedling production was done in an unheated plastic tunnel. The open field spacing was (45+90) x 45cm, one plot consisted of ten plants. Due to four repetitions, one accession or variety was represented by 40 plants. The experimental area was covered by agrotextile and supported with drip irrigation system. The plants were supported with bamboo poles, the side-shoots were removed weekly. Harvest was executed in every week. Fruits were collected in full biological ripening, which were then sorted into three categories: intact, cracked and infected ones. These fractions were weighed, and the fruits were counted. An intact fruit was defined as with maximum 1 cm long wounded scar. The cracked fraction contained those fruits with longer scars, but without any infection. Finally, fruits in the infected fraction showed the visual symptoms of disease infection. The results were visualized in a figure, using kg/m^2 dimension.
For the statistical analysis of yield data, the values of three consecutive harvests were used, the one before peak harvest, the peak harvest, and the one after the peak harvest. The comparison was done with two-way MANOVA test, using Tukey or Games-Howell post-hoc test. The yearly data of fractions were analysed by Marascuillo-test. For the execution of the statistical analysis, IBM SPSS Statistics ver. 25 was used.

RESULTS

The weather conditions of the three experimental years were basically different. While the first year can be characterized as a typical Hungarian summer with long late summer period, the second one was extremely arid, and the third one was seriously humid. These weather extremities provided a good opportunity to investigate the response or investigated PGRs for unfavourable environmental conditions.

In general, the highest yields were given in the first year, followed by those in the third year (*Table 1*). The lowest results were shown in the arid second year. With regards to the biological yield potency, which contains all three fruit fractions, the results were between 4.3-6.2 kg/m^2 in the first, 0.9-1.9 kg/m^2 in the second, and 1.3-3.5 kg/m^2 in the third year. With the exception of the second year, San Marzano showed the lowest or second lowest values. RCAT031257 yielded the highest amount both in the first and second year, while the second arid year was unfavourable for this PGR due to the high occurrence of blossom end rot.

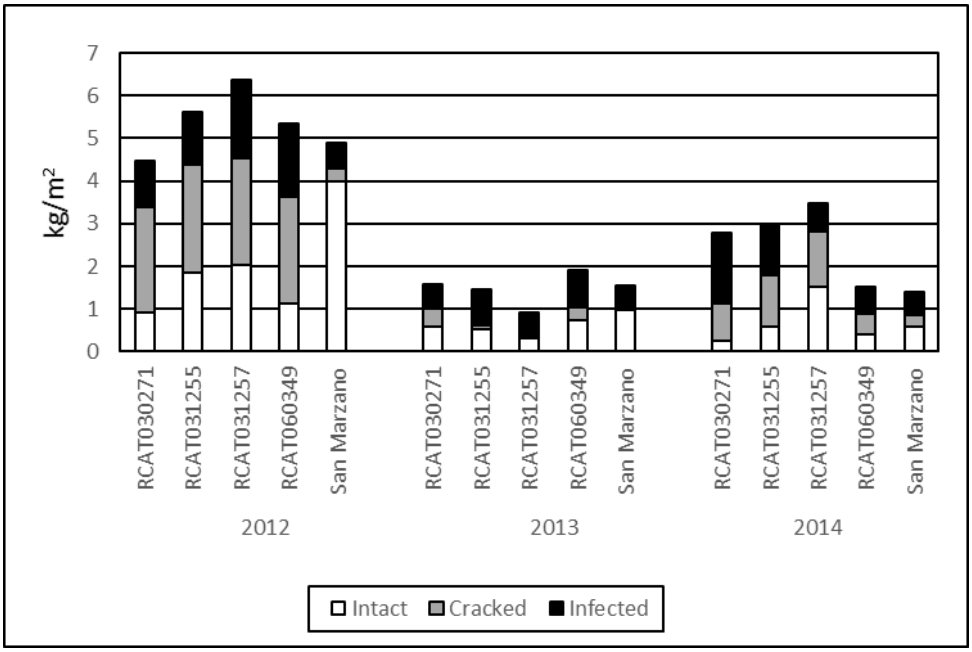

Figure 1. Intact, cracked and infected yield of tomato accessions and the variety over three experimental years (2012-2014)

Regarding the amount of intact fruits, weather conditions had a high impact on the results. In the first year, San Marzano had an outstanding amount of intact fruits, followed by RCAT031257 and RCAT031255. The second year was favourable for San Marzano again, while the weather of the third year ruined its results. In contrast, RCAT031257 could tolerate such extremities and gave the highest intact fruits among the investigated PGRs and the variety. Cracking was mainly the problem of PGRs, causing high wastes, especially in the first year. According to this, infections occurred more frequently on cracked fruits. However, RCAT031257 stands out again with its low infected fraction in the third year. On the other side, over half of the yield of RCAT030271 showed the symptoms of infection.

Due to the high standard deviation of the harvests, no significant differences were found among fractions either within a year, or between years.

CONCLUSIONS

It can be summarized, that yield parameters were highly weather-dependent; the most unfavourable situation is the shortage of precipitation.
In our study it was shown, that the total yield of PGRs are not necessarily lower than that of a commercial variety. However, cracking is a serious problem in the case of such accessions; with slight changes in consumer expectations, these wastes can at least partly utilized. The tolerance of certain PGRs to weather extremities is worth for further analysis.

ACKNOWLEDGEMENTS

The authors thank the financial support of Research Institute of Organic Agriculture (ÖMKi) for the execution of the experiment.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

MYCORRHIZAL INOCULATION OF ONION (*ALLIUM CEPA* L.) IN THE EARLY DEVELOPEMENT STAGES

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ABSTRACT
The onion (*Allium cepa*) is one of the most widely cultivated vegetables. As a food item, it is usually served cooked, as a vegetable or part of a prepared savoury dish, but can also be eaten raw or used to make pickles or chutneys.
Mycorrhiza fungi are special fungi, which live in connection with plant roots. These are symbiotic fungi which have three main types: arbuscular mycorrhiza (AM), ectomycorrhiza and ectendomycorrhiza. AM are probably the most widespread plant symbionts and are formed by 80–90% of land plant species. Crops inoculated with AM have higher yield and quality, and those plants react to stress factors better (e.g. drought, high temperature). Several *Allium* spp. responded with growth promotion on AM inoculation. According to studies AM fungi also has a positive effect on nutrient content.
The aim of our experiment was to find an appropriate method for inoculation of onion seedlings, and define the minimum time for the appearance of symbiosis under greenhouse conditions.
The experiment took place at Szent István University Faculty of Horticultural Science, at the experimental glasshouse of the Department of Vegetable and Mushroom growing, from 11th September 2017. We used Daytona F1 onion seeds, the media was Latagro KB2 type peat and two types of mycorrhizal products: MycoGrow and Aegis Irriga. The experiment was made with 12 treatments with 30-30 seeds per each treatment. During the experiment, chemically treated and non-treated seeds were used. The seedlings were sampled 5, 7 and 14 weeks after sowing, 5-5 seedlings from each treatment per time. Altogether 96 painted and prepared samples were checked, each with 3-3 roots with a Zeiss Axio Imager A2 microscope.
The results showed the appearance of mycorrhizal fungi in a few treatments. In our examination not only typical AM fungi were found, but also in a treatment we found hyphaes with big amount of septas.
The results show opportunity of artificially infecting transplants after a few weeks with mycorrhizal products. However, continuing the experiment is necessary with some modification of the factors, to make the procedure more effective.

Keywords: arbuscular mycorrhiza, onion, seedling, inoculation, colonization

INTRODUCTION

The onion (*Allium cepa* L.) is one of the most widely cultivated vegetables. Its close relatives are the garlic, shallot, leek, chive, which all belong to the *Alliaceae* family. Onions are cultivated and used around the world. As a food item, these are usually served cooked, as a vegetable or part of a prepared savoury dish, but can also be eaten raw or used to make pickles or chutneys (WEB1).
According to FAOSTAT (2018), worldwide, in the last 10 years there were ups and downs both in the harvested area and yields, but due to it, in the last 6 years it seems to stabilize. In Hungary, onion is also one of the most widely cultivated and used vegetable. In 2016, the harvested area was around 2000 ha-s, the yield was 32 t ha^{-1}, but with intensive technology some growers could reach 60-70 t ha^{-1} yield (LEDÓ ET AL., 2017)
Mycorrhiza fungi are special fungi, which live in connection with plants roots. These are symbiotic fungi which have three main types: arbuscular mycorrhiza, ectomycorrhiza and ectendomycorrhiza. Arbuscular mycorrhiza (AM) has aseptated hyphae, colonizes the roots intracellular, most arbuscular mycorrhizal fungi belong to the *Glomero* taxa.

Ectomycorrhiza has septated hyphae, colonizes the roots extracellular, most ectomycorrhiza fungi belong to the *Basidio* or *Asco* taxa. Ectendomycorrhiza has septated hyphae, colonises the root intracellular and the most ectendomycorrhiza fungi belong to the *Basidio* or *Asco* taxa (SMITH AND READ, 2008).

AM are probably the most widespread plant symbionts and are formed by 80–90% of land plant species. This includes numerous important horticultural crops among the *Solanaceae* (e.g. tomato, eggplant or petunia), the *Alliaceae* (e.g. onion, garlic and leek), fruit trees (e.g. grapevine, citrus spp.), ornamentals and herbal plants (e.g. basil, thyme, rosemary) (ROUPHAEL ET AL., 2015).

Crops inoculated with AM have higher yield and quality, and those plants react to stress factors better (e.g. drought, high temperature). Several *Allium* spp. responded with growth promotion on AM inoculation. Onion (*Allium cepa*) plants inoculated with AM, grown in pots with mineral soil had a higher biomass than non-inoculated plants and reached marketable size (>25 mm bulb diameter) 2-3 weeks earlier. This AM inoculation caused furthermore firmer bulb formation of onions. Mycorrhizal inoculation led to 22% increased yields of onions compared to non-inoculated controls (BAUM ET AL., 2015).

Inoculating horticultural crops with AM is becoming common practice, especially in intensive horticultural cropping systems. However, a high-quality inoculum is necessary for successful root colonization with AM (ROUPHAEL ET AL., 2015). According to HART AND FORSYTHE (2012), AM fungi also have a positive effect on nutrient content.

The aim of our experiment was to find an appropriate method for inoculation of onion seedlings, from treated and non-treated seeds and define the minimum time for the appearance of symbiosis under greenhouse conditions.

MATERIAL AND METHOD

The experiment took place at Szent István University Faculty of Horticultural Science, at the experimental glasshouse of the Department of Vegetable and Mushroom growing, 11th September 2017. We used Daytona F1 onion seeds, the medium was Latagro KB2 type peat. Two types of mykorrhizal products were used: MycoGrow and Aegis Irriga. The technical information of MycoGrow said that it could be given for the plant both irrigated and mixed in the media, while Aegis Irriga is just given with irrigation.

The experiment was made with 12 treatments with 30-30 seeds per each treatment. During the trial chemically treated and non-treated seeds were used. The *Table 1* shows the code of the treatments: if the seed is chemically treated or not, the method of the treatment (colonization) and the name of the product and the quantity.

The quantity of the products was calculated from the Technical information. In the case of MycoGrow we used 30 g m^{-2} ratio, while in the case of Aegis Irriga it was 10 g 100 m^{-2} ratio. Amounts of the mycorrhizal products for one tray were calculated from these ratios.

During the experiment, fertilizer and plant protection were not used. Seedlings were irrigated and supplementary lightings were used, when it was needed.

Temperature and humidity were measured during the experiment with a Voltcraft DL-181THP device. The maximum temperature was 28.85 °C, the minimum was 14.33 °C. The maximum humidity was 90.28%, the minimum was 59.94% during the experimental time. During the experimental time, the climate suited for the onion seedlings.

Table 1. Treatments used during the experiment

Treatment Code	Chemically treated +/-	Method of the treatment	Product name, quantity
A	+	mixed in the media	MycoGrow, 5.2 g
B	-	mixed in the media	MycoGrow 5.2 g
C	+	mixed in the media	MycoGrow 10.4 g
D	-	mixed in the media	MycoGrow 10.4 g
E	+	with irrigation	Aegis Irriga 0.017 g
F	-	with irrigation	Aegis Irriga 0.017 g
G	+	with irrigation	MycoGrow 5.2 g
H	-	with irrigation	MycoGrow 5.2 g
I	+	with irrigation	Two product mixed
J	-	with irrigation	Two product mixed
Control +	+	-	no treatment
Control -	-	-	no treatment

The seedlings were sampled 5, 7 and 14 weeks after sowing, 5-5 seedlings from each treatment per time. The first sampling was at 16th October 2017. The second sampling time was at 30th October 2017. The third sampling time was at 18th December 2017. Roots were washed and put in Falcon tubes, filled with 60% alcohol until further measurements.

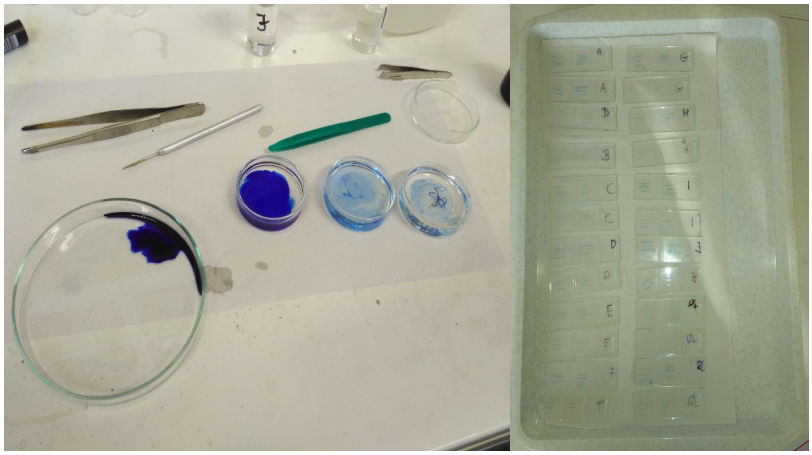

Figure 1. The method of painting; Dissections

To make mycorrhizal fungi visible, a special painting method was used. First, roots were cleaned from the remaining soil parts and from the alcohol with distilled water. Then roots were put in 10% (w/v) potassium-hidroxide and cooked in 60 °C for 60 minutes. Then potassium-hidroxide was washed away with distilled water and roots were put in lactic-acid for a night. The next day the roots were painted with aniline-blue. The roots were put in a bigger Petri-plate, paint was dropped on the roots and after a few seconds the

remaining paint was washed away (*Figure 1*). Then the roots were put in lactic-acid for a night, to properly wash away the unnecessary paint. This painting method can vary a little due to the roots thickness.
After painting, dissections were made from the roots. Aproximately, 1-1,5 cm long pieces from the roots were cut and put in a few drops of lactic-acid on a slide. Three roots were put under each coverslip (*Figure 1*). Altogether 96 painted and prepared samples were checked, each with 3-3 roots with a Zeiss Axio Imager A2 microscope.

RESULTS

The result of the mycorrhizal colonization could be seen in the microscopic pictures. In treatment „C", which was chemically treated, and mixed double dose of MycoGrow in the peat, a long hyphae can be seen. In the hyphae there are no septas (*Figure 2*). These hyphae are long enough, to say, at this treatment the colonization was successful.

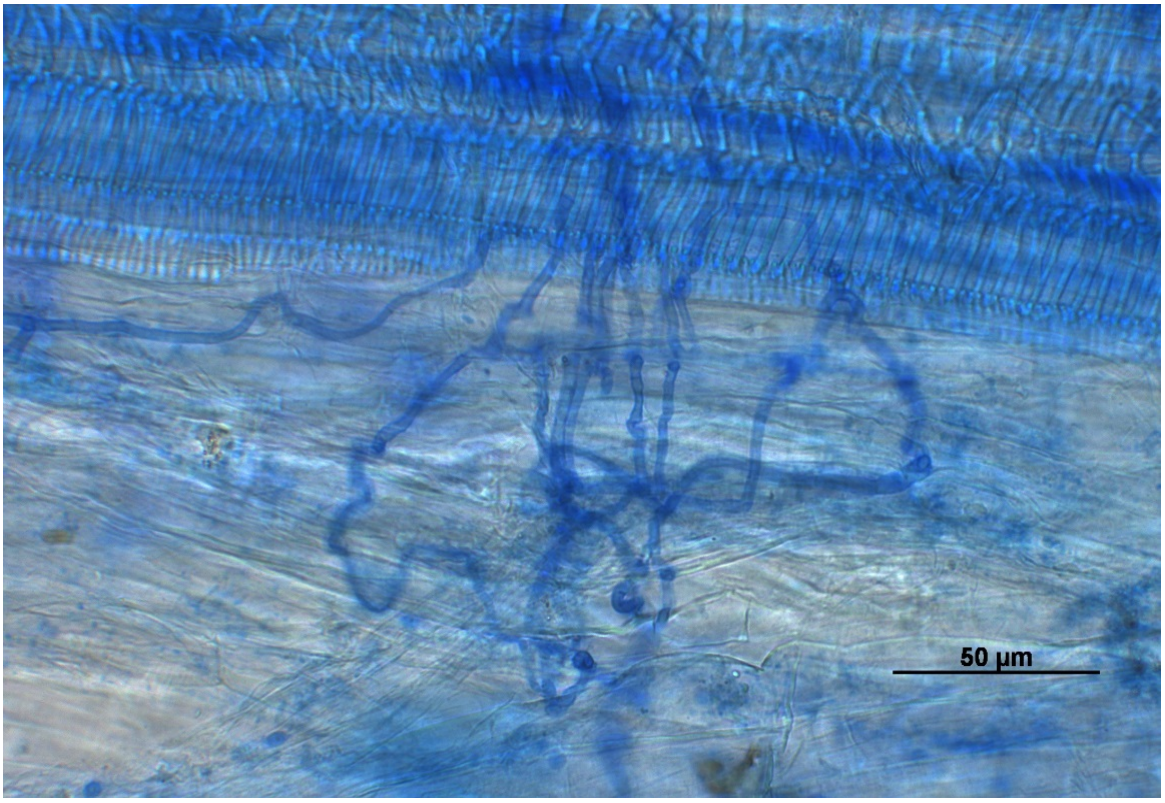

Figure 2. Treatment „C", 2. sampling

There are also mycorrhizal hyphae on *Figure 3* which was taken from Treatment „C" from the second sampling time. In this picture, septas in the hyphae could be seen (arrows), so this was not that type of mycorrhiza fungi we looked for, but its spore could be in the mycorrhizal product beside the other type of mycorrhiza fungi.
In other cases, we did not find any inoculated root from 96 examined roots. Also, there were no remarkable difference between treated and non-treated seeds. However, it is intersting to find an inoculated root in a treatment in which chemically treated seeds were used.

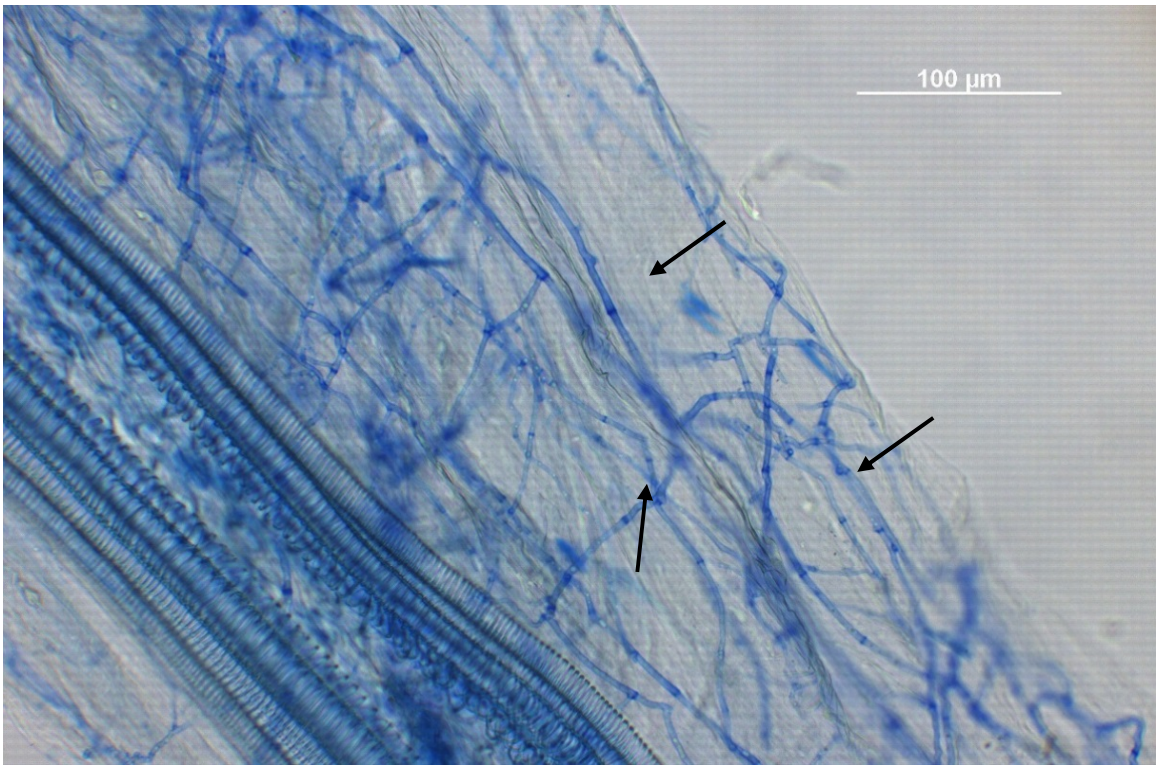

Figure 3. Treatment „C", 2. sampling

CONCLUSIONS

The results showed the appearance of mycorrhizal fungi in a few treatments after 7 weeks from sowing. In our examination not only typical AM fungi were found, but also in a treatment we found hyphae with big amount of septas. Symbiont activity could not be high in our experiment, however in other studies a higher value of colonization was recorded. For example, TAWARAYA ET AL. (2012) had a 94±3% (n=4) colonization on *Allium fistulosum* 58 days (approx. 8 weeks) after sowing. The experiment took place in Japan. There the medium was andosol, the fungal inoculum consisted not only spores, like in our experiment, but also extraradical hyphae and infected roots with *Glomus* R-10. Amount of the inoculum was 75 g kg^{-1}.

Results show opportunity of artificially infecting transplants after a few weeks with mycorrhizal products. However, continuing the experiment is necessary with some modification of some factors (like type of substrate, or used inoculation method), to make the procedure more effective.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

DEVELOPMENT OF *LYCORIELLA INGENUA* AND *BRADYSIA IMPATIENS* ON DIFFERENT PHASES OF AGARICUS COMPOSTS

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ABSTRACT
Fungus gnats are small, dark colored, mosquito like fragile insects. They can be encountered all around the world, excluding places with extreme climate. Gnats prefer habitats that are damp with high relative humidity and rich in organic debris. Most of the species are not considered to be harmful in agriculture, but some may cause serious damage, especially in forcing of vegetable or ornamental plants. In mushroom production, however, they are considered as the most destructive pests; the damage caused by them alone can result in huge loss for mushroom farmers. In the Hungarian mushroom industry, fungus gnats damage mainly white-button mushroom, oyster mushroom and pioppino productions. *Lycoriella ingenua* (DUFOUR, 1839) and *Bradysia impatiens* (JOHANNSEN, 1912) are the two most commonly found fungus gnat species from the family *Sciaridae* on Hungarian mushroom farms.
We have conducted an experiment with the two aforementioned species, to find out, whether they can fully develop into adults, feeding purely on Agaricus compost diet. We used unspawned white button mushroom compost (phase 2) and spawned compost which has been colonized by the mycelia of *Agaricus bisporus* (phase 3). We did not conduct any experiment with the first compost phase, as it undergoes pasteurization, which eliminates any pests in it. We recorded emerging gnats only from phase 2 compost. Neither *L. ingenua*, nor *B. impatiens* could complete its development on phase 3 compost diet, furthermore not even pupae were observed in these breeding pots. From pots containing phase 2 compost, a total of 1607 adults emerged. The number of *B. impatiens* adults was 653, and 954 for *L. ingenua*. Sex ratios for the two species were different. For *B. impatiens*, the number of females was 1.36 times greater than that of males, in *L. ingenua* there were 1.7 times more males than females in total. Swarming took approximately 6 days for *B. impatiens* and 10 days for *L. ingenua*. From the experiment we can conclude that phase 3 compost, which is well interwoven with *Agaricus bisporus* mycelia is not suitable for *B. impatiens* and *L. ingenua* to complete their whole life cycle.

Keywords: fungus gnat, *Agaricus bisporus*, compost, mushroom cultivation

INTRODUCTION

Insects from the family Sciaridae can be encountered all around the world. In nature, the sciarid flies can be found within tree trunks colonized by fungi, under bark or in manure piles or under fallen leaves as well (BINNS, 1981). Most of the species feed on soil dwelling fungi and are not deemed to be harmful in agriculture (MEAD AND FASULO, 2001). Nevertheless, there are some which can damage agriculturally important plants such as ornamentals and vegetables (HUNGERFORD, 1916; MEAD AND FASULO, 2001). In mushroom cultivation, the fungus gnats cause their damage directly and indirectly. The direct damage is attributed to the larvae, which feed on the compost, thus taking away nutrient from the mushroom mycelia. Additionally the excrement of larvae inhibits the growth of mycelia. In some cases, the larvae can damage the forming pinheads as well, and may burrow themselves in the stalk of mushrooms (LEWANDOWSKI ET AL., 2004). The indirect damage is caused by the adult insects, which act as vectors for fungal pathogens of edible mushrooms (SHAMSHAD, 2010). Every segment of the mushroom industry provides

an ideal habitat for fungus gnats. During compost production, the different phases are transported by the help of conveyer belts, wheel loaders and trucks, from which some compost unintentionally falls off, thus creating potential food source for gnats where they can develop undisturbed. Mushroom production requires manual labor, that inevitably leads to some compost ending up on the floor and remaining uncollected. These conditions are always available, since mushroom production is continuous throughout the calendar year.

MATERIAL AND METHOD

Fungus gnat species

During our experiment, we worked with the two most commonly found sciarids in Hungarian mushroom production, *Lycoriella ingenua* and *Bradysia impatiens*. *L. ingenua* is reported to be the most serious pest in mushroom production, especially in white button mushroom cultivation (MENZEL AND MOHRING, 1997), while *B. impatiens* tends to be more common in plant forcing (CLOYD, 2008) but may be present at mushroom farms as well. The morphology of the two species does not differ significantly at the first sight. Both species are small, 2-5 mm long, delicately structured, dark brownish or black colored insects, with large compound eyes and long antennae. The life cycle and environmental needs are identical for the two species, and the damage symptoms do not differ either. Identification of the two species can be done visually, they differ in the armature of the fore tibia, the male genitalia and the length of the antennal flagellomeres.

Collection of specimens and establishing the fungus gnat cultures

The necessary insect-material was collected from a mushroom farm in Ócsa, on the date of 05.02.2018. Initially, we collected more than 500 insects, which were transported to the Department of Vegetable and Mushroom Growing of Szent István University for further studies. Because it is impossible to collect "pure" populations of single species at growers, we had to establish these pure colonies in laboratory. Mating pairs of fungus gnats were isolated from the rest of the group. After the mating process was completed, we isolated the inseminated females individually in breeding pots containing phase 2 Agaricus compost (one female per breeding pot). For species identification, we collected the male gnats after mating, and examined the hypopygium. Based on the outcome of this identification process, we determined which breeding pots contained *Lycoriella ingenua* and *Bradysia impatiens*. In the trial, we used phase 2 and phase 3 Agaricus composts, and for each of the species we have used 12 replicates. The breeding pots were created by filling the composts into plastic containers (870 ml) and covering them with plastic-fiber veils. Each of the breeding pots contained only one inseminated female. During the experiment, the pots were stored in an environmental control chamber in the absence of light, at 23 °C with the relative humidity set to 85%. We evaluated the results by recording the number of emerged adults in the breeding pots according to species and sex from the start of the swarming, until the end of it. At the end of each day, the asphyxiated adults were not released back into the breeding pots.

RESULTS

Number of emerged adults

We have recorded a total of 1607 adults independently from sex or species, which meant an average of 66.9 adults per breeding pot. The mortality rate was between 33.1% and

55.4% compared to the average number of eggs laid by the isolated females (100-150). We have recorded zero number of *Lycoriella ingenua* or *Bradysia impatiens* on phase 3 Agaricus compost in either experimental trials. From the start of the experiment, we have collected a total of 954 *L. ingenua* and 653 *B. impatiens* adults on phase 2 Agaricus compost (*Figure 1*). This means that the average number of eggs laid was 79.5 for *L. ingenua* and 54.4 for *B. impatiens.*

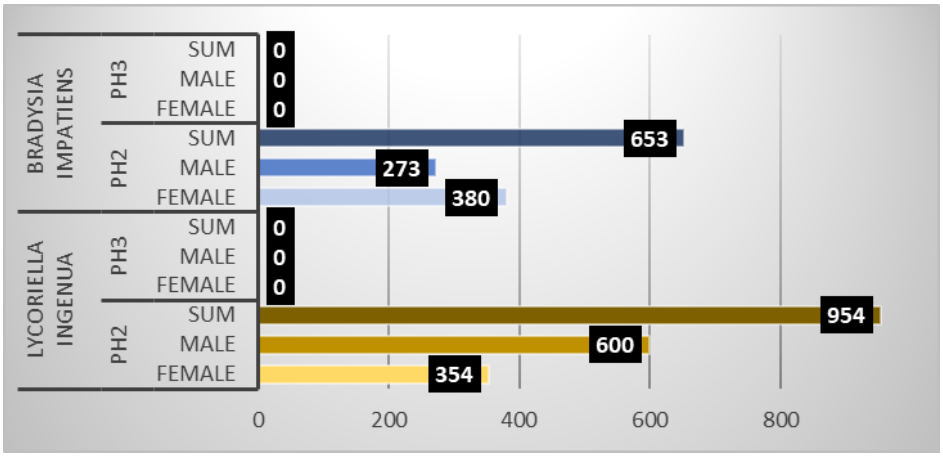

Figure 1. Total number of emerged adults by species and sex

Distribution of male and female insects

In the case of *Bradysia impatiens* a higher number of female adults emerged than males (380 and 273). This phenomenon was reversed in *Lycoriella ingenua*, where the emerged males were in greater number than female insects (600 and 354). The population of *L. ingenua* was composed of 63% male and 37% female adults, which gave the sex ratio of 1.69 male : 1 female. The distribution of sex was more even in *B. impatiens*, the sex ratio was 1.36 female : 1 male, which meant that the population was 43% males and 58% females, respectively (*Figure 2*).

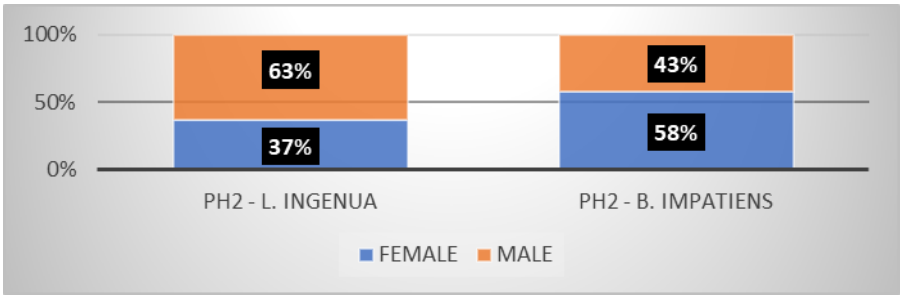

Figure 2. Sex ratio of *L. ingenua* and *B. impatiens*

Emergence dynamics of *Bradysia impatiens*

First insects were recorded on the 12th of March; 47 female and 73 male insects were collected. The following day, we asphyxiated 89 females and 95 males more. On the 14th of March, the number of captured females exceeded that of the males (109 females to 66 males). After this date, even the number of female adults started to decline. On the 17th of March, we only collected 11 female insects, and on the 18th, no gnat was collected from any of the breeding pots. The duration of swarming took approximately 6 days (*Figure 3*).

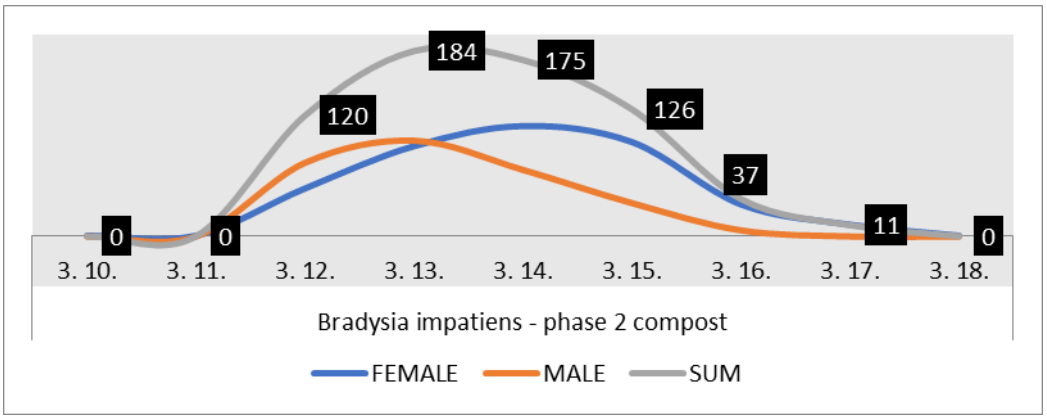

Figure 3. Emergence dynamics of *B. impatiens*

Emergence dynamics of *Lycoriella ingenua*

On the 12th of March we have captured a single female and 24 male gnats from the breeding pots. A sharp and steady rise in the number of male adults could be seen until the 15th of March, from which onward the abundance of male gnats decreased strongly. The last male gnats were collected on the 18th of March. In the case of female gnats, a slow but steady increase was observed, the peak number of captured gnats was on the 16th of March (75), after that, the number of females slowly decreased. The last female specimens were asphyxiated on the 21th of March. The swarming of *L. ingenua* took approximately 10 days (*Figure 4*).

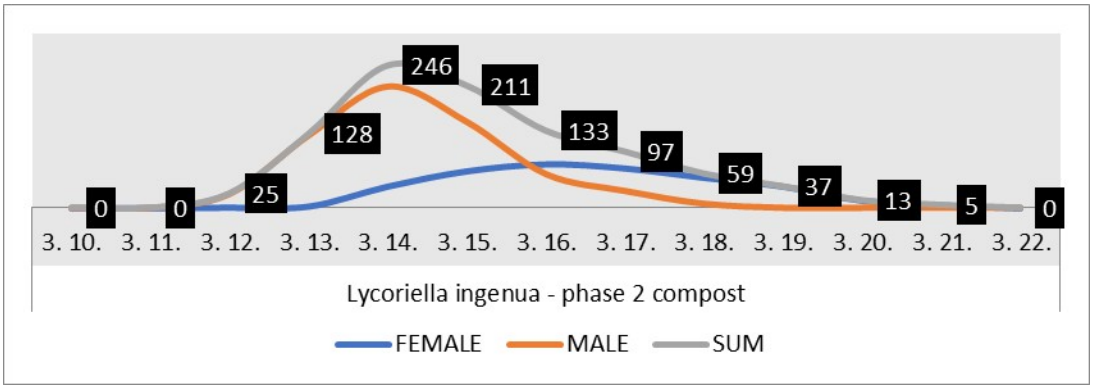

Figure 4. Emergence dynamics of *L. ingenua*

DISCUSSION

Based on our results, we have concluded that both *Lycoriella inganua* and *Bradysia impatiens* can develop into adult stage purely on phase 2 Agaricus compost. According to our recorded data, we found, that the number of total insects was greater in the case of *L. ingenua*, than *B. impatiens*. Emerging adults of *L. ingenua* were 46% more numerous, than that of *B. impatiens*. However, it did not mean that the fecundity of *L. ingenua* is greater than that of *B. impatens*. We have not found literature, which would have supported the theory. The difference may have been the result of varying mortality of the two species in this experiment.

The distribution of male and female insects was quite different between the two species. The sex ratio was more skewed towards males in *L. ingenua*, and in the case of *B.*

impatiens, the two sexes were more in equilibrium. This is because of the genetic nature of how progenies are formed in the two species. In fungus gnats, the determination of sex and consequently sex ratio in populations, is based on how the X-chromosomes are eliminated during PGE (paternal genome elimination). In certain species of sciarids, the females either produce unisexual progenies (monogenic) or in other species, the progenies deriving from one female can consist of males and females alike (digenic). In monogenic species the sex ratio is closer to 1:1, while digenic species' sex ratio can considerably differ from 1:1. (METZ and SCHMUCK, 1929; HERRICK and SEGER, 1999; ROCHA AND PERONDINI, 2000). In some of the sciarid species, the two phenomena (monogenic and digenic females) can occur at the same time (ROCHA AND PERONDINI, 2000). *B. impatiens* is a monogenic (METZ, 1925; ALBERTS *et al*., 1981) sciarid species, while *L. ingenua* is digenic (STEFFAN, 1974), which is why the sex ratios were observed different in our studies. Based on our findings we may suggest, that the food source does not influence the sex ratio of progenies. This is further established in our previous study, where we have compared different substrates for the development of *B. impatiens*, and the average sex ratio of the population did not differ from 1:1; it was 46:54 males to females, respectively (KECSKEMÉTI, 2017). However, certain environmental factors, such as temperature may have an effect on the sex ratio of progenies of certain fungus gnat species (CHENG ET AL., 2017).

The fact that zero number of adults have been recorded on phase 3 Agaricus compost either in the case of *B. impatiens* or *L. ingenua* is quite intriguing. It was a known fact to us that an Agaricus compost fully interwoven with the mycelia of *Agaricus bisporus* is not preferred by fungus gnat females for oviposition, and sub-optimal for larval development. The observed complete inhibition of development, however, was not expected. It is reported that the accumulation of calcium-oxalate crystals found in the *Agaricus bisporus* mycelia negatively affects the development of fungus gnat larvae (BINNS, 1980; WHITE, 1997; CHANG AND MILES, 2004). Previous experiments showed similar results (KECSKEMÉTI, 2017), from which we may suggest, that purely on phase 3 Agaricus compost, which is well colonized by *Agaricus bisporus* mycelia, the sciarid fly *B. impatiens* and *L. ingenua* cannot develop into the adult stage.

ACKNOWLEDGMENTS

 Supported by the ÚNKP-17- 3 new national excellence program of the ministry of human capacities.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

RESEARCH OF MIDSEASON POTATO VARIETIES SUITABLE FOR ORGANIC GROWING

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ABSTRACT
An essential issue in organic potato production is choosing the right varieties, because varieties grown under conventional conditions may not always be suitable for organic production. The choice of variety was based solely on farmers' experience, as research results were not available. Because of the lack of reliable information, ÖMKi initiated an on-farm research program for organic potato production in 2012.
13 mid-season potato varieties with certain degree of resistance to relevant diseases or abiotic stresses were tested on 22 organic farms (2012-2015) in close cooperation with the growers. Quantitative and qualitative parameters were assessed at harvest. The average yield was 2.19-3.45 kg/m² (21-34 t/ha). Among seven qualitative parameters the most relevant quality problems were: *Streptomyces* and *Rhizoctonia* infection and damage by insect pests. No significant differences could be shown among the varieties regarding the assessed parameters, but disease resistance often differed compared to the descriptions provided by the seed tuber distributors.
Besides summarizing and sharing research results, regular meetings and field trips were arranged for farmers. As an indirect result of the on-farm research program the communication was highly improved among the participants and a well-working organic potato workgroup was formed.

Keywords: potato, *Streptomyces*, soil pH, *Rhizoctonia,* resistance

INTRODUCTION

Until recently potato varieties grown by Hungarian organic potato growers were the same as used in conventional agriculture, although not all of these varieties may be suitable for organic growing. The choice of variety was based solely on farmers' experience, as research results were not available. Unlike in other European countries, organic potato trials are not widespread in Hungary, until 2012 only one trial has been done (KOVÁCS ET AL., 2006). Moreover, certified organic potato cropping area in Hungary is relatively small, the communication and cooperation among stakeholders is relatively weak.
To fill the knowledge gap and to increase the communication among Hungarian organic potato growers, an on-farm participatory research program was run by ÖMKi in 2012-2015. The approach of on-farm participatory research was unknown in Hungary before, the introduction and adaptation was based on similar research network of FiBL Switzerland and FiBL Austria (Bio-Net AT).

MATERIAL AND METHOD

Methodology of trials

The trials were conducted as part of the on-farm participatory research program of ÖMKi, with 22 cooperating organic farms in several growing regions in Hungary (*Figure 1*). The size and character of the farms were either small, garden-scale micro farms cultivated by hand-driven methods, or mechanized farms using arable rotation and machinery.

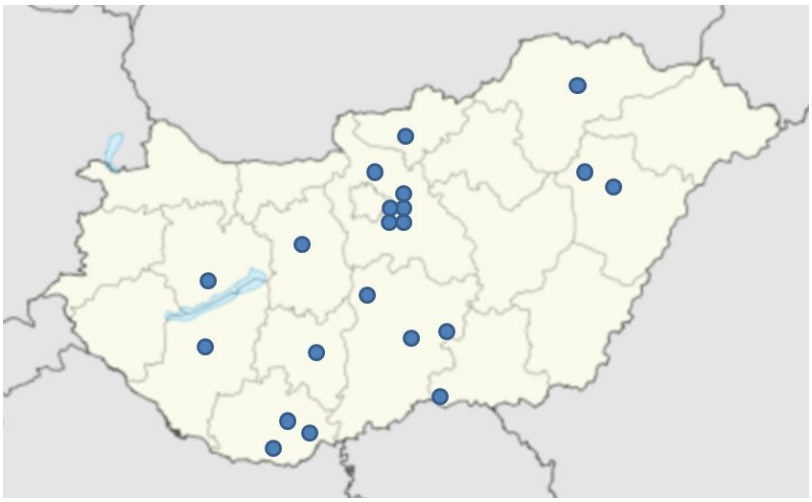

Figure 1. Organic farms participating in the potato on-farm participatory research program in Hungary, 2012-2015

A common midseason cultivation method was proposed to growers involved in the trials: The minimum size of the test plots was 12 m² for each variety in the garden-scale farms (60 tubers were planted per variety), in arable farms the size of parcels were adjusted to the size of the field and the type of available machines. The spacing of plants was generally 70x30 cm. The tubers were usually planted in mid-April. Irrigation was recommended but depended on the abilities of each farm. Plant protection solutions were also recommended, but the exact system was chosen by the farmers: usually copper was used against *Phytophtora*, *Bacillus thuringiensis* var. *tenebrionis* or *spinosad* against potato beetle, and some of them also used plant conditioner materials. The harvest usually happened in August-September, after the foliage had withered. Fertilization was conducted according to general organic practices.
Although a common midseason cultivation method was proposed, the participating farmers determined their own production methods throughout the year, so smaller differences appeared. For the comparability of data, only those farms' data were processed and summarized that adapted the proposed midseason potato cultivation method. Therefore, out of 47 data series of 22 farms only 28 data series of 12 farms were analysed statistically. The remaining 19 data series could not be analysed because unforeseen vis maior events, discrepancies or missing soil data.

Tested varieties
Varieties with certain degree of resistance to relevant diseases or abiotic stresses were chosen for testing. The variety selection was based on Hungarian bred varieties in 2012, but the selection was modified year by year, according to trial results (*Table 1*). The seed tubers were not treated with any material before planting.

Methodology of assessments
The details of each year's cultivation were recorded by the farmers. Quantitative and qualitative parameters of 13 midseason potato varieties were assessed. At the end of harvest yield was recorded by farmers (kg/m²). Unsorted samples of 50 tubers were taken from each test plot of each variety. We conducted a visual inspection of the tubers' surface and recorded infections by *Streptomyces*, *Rhizoctonia*, *Fusarium*, *Erwinia*; severe damage by pests and by harvesting equipment. Deformed and greened tubers were also recorded. The presence of quality problems was recorded not the degree of the damage.

Table 1. The list of potato varieties tested in 2012-2015

Nr.	Variety name	2012	2013	2014	2015
1	Arany Chipke				x
2	Barna				x
3	Bettina			x	
4	Big Rossa			x	
5	Dalida		x		
6	Démon	x	x	x	x
7	Desirée	x			
8	Hópehely	x	x	x	
9	Katica	x			
10	Shannon				x
11	Tiamo		x	x	
12	Vénusz Gold	x			
13	White Lady	x			

Methodology of statistics

Different statistical analyses were applied in order to identify differences among potato varieties regarding quality issues, and to find connections between yield and other environmental measures, such as soil pH levels. Therefore, correlation and variance analysis were used. The former analysis is a measure of the strength and direction of the relationship between variables. Since the used variables were either ordinal variables, or their distribution was not bivariate normal, the Spearman's rank-order (often abbreviated to Spearman's correlation) method was chosen to calculate a coefficient, r_s. Because of the same reason, the variance analysis methods used were either the Mann-Whitney U test, which is a rank-based nonparametric test, or the Kruskal-Wallis H test, if there were more than two groups of independent variables.

RESULTS

Results of quantitative parameters (yield)

The average yield of varieties varied according to climatic conditions of the growing season, but ranged between 2.1-3.4 kg/m² (21-34 t/ha). There were no significant differences between the trial years' average yield results.

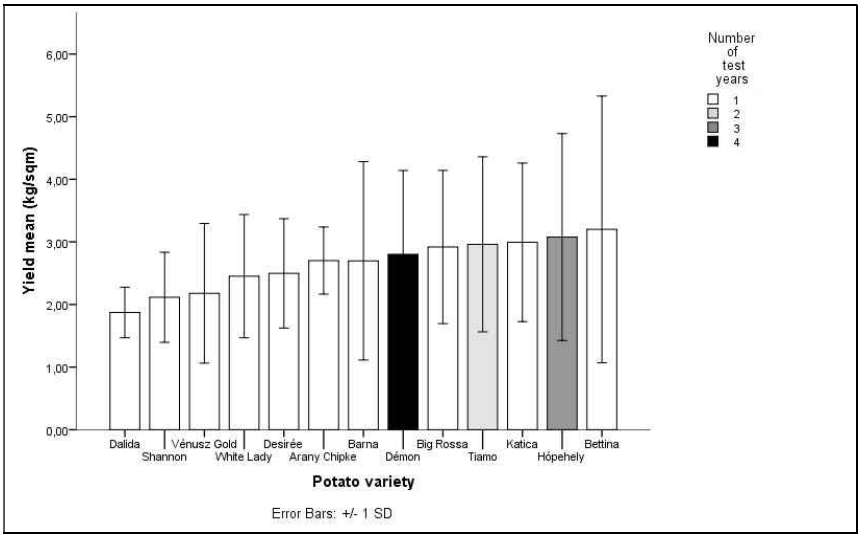

Figure 2. Average yield of varieties tested in 2012-2015 (kg/m²)

There were big differences among the varieties' average yield production (*Figure 2*), although the differences were not significant. Yield results were compared with parameters of trial sites and technologies, and moderate strong correlation was found with the pH level of the soils, $r_s(99) = .347$, $p < .01$. The higher the pH level was, the more yield was measured.

Results of qualitative parameters

The most common quality problem was common scab (*Streptomyces* spp.*)* infection (average 15.9%). The damage of pests (6.23%) and *Rhizoctonia* infection (5.9%) occurred on a lower level (*Figure 3*).

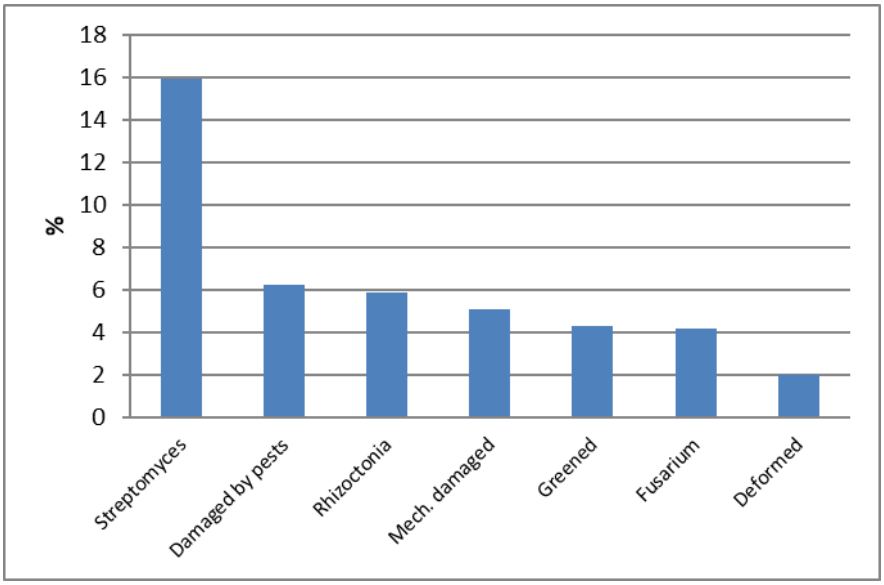

Figure 3. Average proportion of tubers with quality problems (all varieties, all years, data of 14 farms)

***Common scab** (Streptomyces spp.)*

Among the eight measured quality problems the common scab (*Streptomyces* spp.) infection proved to be the most frequent problem in all of the four years. This disease causes serious problems for both organic and conventional cultivation, but its severity may be different (TEIN ET AL., 2015). Scab resistance may differ among varieties and using resistant varieties is the most reliable control method for common scab (DEES AND WANNER, 2012; WANNER AND KIRK, 2015). Since the tested varieties are results of conventional breeding programs, their resistance might not be valid for organic cultivation. In our trials the varieties showed different scab infections not only compared to each other but also compared to the breeders' variety descriptions (*Table 2*).

Among the varieties tested in more than one year, the least infected tubers were found in samples of 'Hópehely' (2.74%, average of 3 years), the most were in samples of 'Démon' (19.84%, average of 4 year). There were no statistically significant differences among the susceptibility of varieties.

Pest damage

Among the eight quality problems the damage of several insect and non-insect pests (*Agriotes* and *Gryllotalpa* larvae, slugs) was the second most common problem. The highest degree of damage appeared in 2013. Presumably, the pests were looking for water in the tubers, since it was a very dry season. Regarding the all of four years, the most frequent pest damage was caused by the larvae of *Gryllotalpa gryllotalpa.* As source of

infection, the farmers marked the applied compost and farmyard-manure. The pest management against European mole cricket is a difficult challenge for organic growers.

Table 2. Evaluation of varieties' resistance to common scab according to organic on-farm trial results vs. conventional references

Variety name	Resistance to common scab according to references (Scale – where appropriate –of 1 to 9, where 9 is most desirable)	Average infection rate in our trials (%)	Trials' experiences compared to references
Arany Chipke	resistant	14.29	↓
Barna	resistance to common scab: 6	18.00	↓
Bettina	resistance to common scab: high	6.33	→
Big Rossa	resistance to common scab: medium - good	9.63	→
Dalida	resistance to common scab: 7	4.00	↑
Desirée	resistance to common scab: 4	9.33	↑
Démon	resistant	9.92	↓
Hópehely	resistance: medium	1.37	↑
Katica	resistant	3.00	→
Shannon	resistance to common scab: 7	13.13	↓
Tiamo	resistance to common scab: 7,5	8.80	→
Vénusz Gold	resistant	4.4	→
White Lady	resistant	2.2	→

Source: Papp, 2016

Black scurf (Rhizoctonia solani)

Among the eight quality problems black scurf (*Rhizoctonia solani*) infection was the third most common during the four years of the trial. The varieties showed different susceptibility to *Rhizoctonia*, however, the differences were not significant. The proportion of infected tubers was highest in the samples of 'Big Rossa' (15.18%, tested in one year), and there was no infection in samples of 'Arany Chipke' and 'Katica'.

CONCLUSIONS

The following conclusions can be drawn from the study:

- On-farm participatory research is a very useful approach to generate practical information on the agronomic characteristics of varieties. Due to the variety of soils and cultivation methods used on the participating farm-sites, we could get meaningful information on varieties' performance.
- Regarding all of the data in all of the four years, the most common quality problems of Hungarian organic potato production were common scab (*Streptomyces* spp.*)* infection, damage of pests and *Rhizoctonia* infection.
- Yield results compared with parameters of trial sites and technologies, moderate strong correlation was found with the pH level of the soils.
- Our results regarding common scab resistance were different from variety descriptions given by seed tuber distributers in many cases, so variety testing in organic farming proved to be useful.
- After summarizing the data of the four-year trials, the best performing varieties were proposed to farmers according to specific characteristics of their farms.
- Throughout the management process of the on-farm program we collected unique

information about the Hungarian organic potato sector – there were no research data available on this issue on national-scale before. Further research topics could be identified based on these new data in cooperation with farmers.

- There were big differences among involved farms regarding yield and quality parameters. During the trials, apart from the scientific work, knowledge-exchange could also be implemented to improve farm yields.
- Besides summarizing and sharing research results, regular meetings and field trips were arranged for farmers and other stakeholders of the potato supply chain. Communication was highly improved among the participants and a well-working organic potato workgroup was formed.

ACKNOWLEDGEMENTS

The authors would like to thank all the farmers for their enthusiasm, openness and lots of work. Thanks to Zsolt Polgár (Potato Research Institute, Hungary) for his support through the whole project and for Bernhard Speiser (FiBL Switzerland) for helping to start the project. Also thanks to all of the merchandizers who offered the potato tubers to the project for free.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

THE EFFECT OF DIFFERENT WEED CONTROL TECHNOLOGIES ON WEED SPECIES COMPOSITION OF MAIZE

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ABSTRACT
In our investigation we used different weed control technologies in the different phenology states of the maize. The farm experiment has been carried out in Hungary, Kunágota, on flat surface, homogeneous quality chernozem soil, on 1000 m^2 plots, in 4 replications.
The experiment can be regarded as 9 weed-control strategies where, in addition to the untreated control, two chemicals are applied (Laudis, Capreno) in different doses, two mechanical weed-control technologies, and two combination of chemicals and mechanicals weed-control technologies were used. Mechanical weed-control place connected to the herbicide treatments in different times: until 4-6-leave age weedless, in 4-6-leave age hoed once, in 4-6-leave age cultivation once.
Our results were assessed by chemical efficiency examination in five periods. Our resoult show that the two tested herbicides were efficient against weeds. Laudis was more effective, than Capreno against *Setaria pumila*. The dose enlargement of Capreno only slightly increased the herbicidal efficiency. The decreased dosage of Capreno was not efficient enough against *Abutilon theophrasti*.

Keywords: maize, mechanical weed-control, combination of chemicals and mechanicals weed-control, mechanicals weed-control, weed survey

INTRODUCTION

In the past decades, maize was produced on the largest scale in Hungary. Weeds mean one of the most important problems in maize fields (NAGY AND SÁRVÁRI, 2005.). The weed-control of maize is possible with mechanical weed-control technologies, with chemicals and with combination of chemicals and mechanicals weed-control technologies, aside from the agrotechnical methods. The right decision on protection, which focuses on only the occurring species, can suitably repress their presence, and can halt future spreading in the given crop, can only be made with suitable knowledge of our arable lands and the weeds that infect those.
Since the fourth national weed field survey (1996-1997), significant changes have taken place in our arable lands (GYULAI ET AL., 2016). The past one and a half decades have seen a rearranging of the ownership structure of Hungary's lands, with the number of people farming small areas of land having increased together with the sizes of the lands they farm (ÁNGYÁN, 1997). This has also led to substantial changes in the dominance relationships of field crop weeds, which in turn has increased the spreading of several weed species (NOVÁK ET AL. 2009.). In addition to all the above, a change in herbicide use is one of the other important factors that plays a role in weed flora changes.
Adjudication of the different methods happen by weed survey (ASPINAL AND MILTHORPE, 1959; BLEASDALE, 1960; HARPER, 1961, 1977; DONALD, 1963).

The object of our study is that we determine the effect of different weed-control technologies of maize on weed species composition and on weed control efficiency.

MATERIAL AND METHOD

The experiments were carried out in Békés county, Kunágota, in 2017 on good quality, homogeneous, flat surface chernozem soil. Sunflower was the forecrop of our farm experiment. The sunflower forecrop was sprayed with Pulsar. As fertilizer, 54 kg ha^{-1} N active agent was emitted in springtime. The sowing was done with Dekalb DKC 5275 maize hybrid, on 5 April 2017, with 70,000 seeds m^{-2} amounts of seeds, interline spacing was 75 cm. The research was established farm conditions on 20 x 50 m plots. *Table 1* shows the applied weed-control technologies in the experiment.

Table 1. Weed-control technologies in the experiment

Treatments	Rate (l ha^{-1})	Mode of application
1. untreated control		all the time weedy
2. mechanical weed-control		in 4-6-leave age hoed once
3. mechanical weed-control		until 4-6-leaves age weedless
4. Laudis	2	postemergence (in maize 4-6-leaves age)
5. Capreno	0.4	postemergence (in maize 4-6-leaves age)
6. Capreno	0.3	postemergence (in maize 4-6-leaves age)
7. Capreno	0.2	postemergence (in maize 4-6-leaves age)
8. Laudis	2	postemergence (in maize 4-6-leaves age) + in 4-6-leaves age cultivation once
9. Capreno	0.3	postemergence (in maize 4-6-leave age) + in 4-6-leaves age cultivation once

Table 2 contains the meteorological data during the time of the experiment.

Table 2. Meteorological data during the experiment

Months	Decade	Average temp. (°C)	Precipitation (mm)
April	1.	12.25	10
	2.	9.3	22
	3.	12.1	4
May	1.	15.35	6
	2.	18.25	20
	3.	19.18	20
June	1.	21.25	16
	2.	21.18	7
	3.	25	13
July	1.	23.7	1
	2.	22.9	11
	3.	23.86	31
August	1.	27.75	14
	2.	23.85	18
	3.	21.31	0
September	1.	20.27	35
Total			**228**

We estimated the applied weed-control methods with weed surveying in 4 repeats, on 2 x 2 meter random layout plot. We performed weed surveying five times:

- before treatments (16 May 2017)
- 2 weeks after treatments (31 May 2017)
- 1 month after treatments (14 June 2017)
- in maize flowering age (5 July 2017)
- before harvest (9 September 2017)

RESULTS

Table 3 contains the weed species composition of the control parcel and *Table 4* shows the effect of examined weed-control methods.

Table 3. The weed species composition of control parcels

Latin name	Bayer code	Dates of weed survey				
		16 May	31 May	14 June	5 July	9 September
Abutilon theophrasti	ABUTH	1.12	3.12	3.63	3.78	3.88
Amaranthus retroflexus	AMARE	0.25	5.25	6.88	7.20	7.50
Ambrosia artemisiifolia	AMBEL	0.63	6.12	8.25	9.83	10.13
Capsella bursa-pastoris	CAPBP	1.00	2.12	2.63	2.69	2.88
Chenopodium album	CHEAL	3.29	6.13	9.25	9.03	9.13
Convolvulus arvensis	CONAR	1.34	2.12	2.25	2.33	2.63
Datura stramonium	DATST	0.59	3.75	4.50	4.68	4.88
Helianthus annuus	HELAN	8.04	14.50	16.13	17.43	20.13
Persicaria maculosa	POLPE	0.32	1.12	2.25	2.43	2.63
Rubus caesius	RUBCA	0.00	0.50	0.55	0.63	0.69
Setaria pumila	SETPF	4.71	5.13	5.88	7.63	10.83
Taraxacum officinale	TAROF	0.11	0.20	0.35	0.56	0.83

The weed species composition of control parcels for characteristics to weed flora mainly consisted of late-summer annual weeds belonging, we found a few perennial weeds (*Convolvulus arvensis, Rubus caesius, Taraxacum officinale*).

We have observed that in 4-6-leaves age cultivation once, after the mechanical control on the parcels weeds soon germinated, so we found more and more T4 type weeds. The two tested herbicides were efficient against weeds on chemical control parcells (4., 5., 6., 7., 8., 9.), however the mechanical control treatments (8., 9.) did not significantly affect herbicidal efficiency. The dose enlargement of Capreno only slightly increased the

herbicidal efficiency, however the decreased dosage of Capreno was not efficient enough against *Abutilon theophrasti*.

CONCLUSIONS

Weed flora mainly consisted of late-summer annual weeds belonging to T4 type, we found a few perennial weeds (*Convolvulus arvensis, Rubus caesius, Taraxacum officinale*). We found more and more T4 type weeds after the first hoeing of the maize.
The 2 tested herbicides were efficient against weeds. Laudis was more effective, than Capreno against *Setaria pumila*. The dose enlargement of Capreno only slightly increased the herbicidal efficiency. The decreased dosage of Capreno was not efficient enough against *Abutilon theophrasti*.

Table 4. Weed-control efficiency in different weed control technologies

Treatment No.	No. of weed survey	ABUTH	AMARE	AMBEL	CAPBP	CHEAL	CONAR	DATST	HELAN	POLPE	RUBCA	SETPF	TAROF
2.	2.	100	93	100	100	81	100	83	94	78	100	60	100
	3.	100	97	100	100	85	100	88	97	80	100	65	100
	4.	97	95	100	91	89	100	85	98	90	100	53	100
	5.	97	95	100	91	89	100	85	99	90	100	52	100
4.	2.	76	100	100	96	100	88	100	100	78	100	90	100
	3.	83	100	100	100	100	89	100	100	89	100	88	100
	4.	83	100	100	100	100	89	100	100	100	100	87	100
	5.	84	100	100	100	100	95	100	100	100	100	86	100
5.	2.	100	100	100	100	98	100	100	100	100	100	89	100
	3.	100	100	100	100	99	100	100	100	100	100	87	100
	4.	100	100	100	100	99	100	100	100	100	100	89	100
	5.	100	100	100	100	99	100	100	100	100	100	85	100
6.	2.	100	98	100	100	99	100	100	99	100	100	83	100
	3.	100	100	100	100	97	100	100	98	100	100	85	100
	4.	100	100	100	100	98	100	100	100	100	100	86	100
	5.	100	100	100	100	98	100	100	100	100	100	82	100
7.	2.	80	100	100	100	85	100	100	100	100	100	68	100
	3.	80	100	100	100	94	100	100	100	100	100	72	100
	4.	78	100	100	100	94	100	99	100	100	100	80	100
	5.	70	100	99	100	94	100	98	100	100	100	80	100
8.	2.	85	100	100	96	100	88	100	100	78	100	90	100
	3.	93	100	100	100	100	89	100	100	89	100	88	100
	4.	93	100	100	100	98	89	99	100	100	100	87	100
	5.	94	100	100	100	98	95	100	100	99	100	86	100
9.	2.	90	98	100	100	99	100	100	99	100	100	83	100
	3.	95	100	100	100	97	100	100	98	100	100	85	100
	4.	99	100	100	100	98	100	98	100	100	100	86	100
	5.	97	99	100	100	98	100	99	100	99	100	82	100

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

THE EFFECT OF DIFFERENT WEED CONTROL TECHNOLOGIES ON YIELD OF MAIZE AND PROFITABILITY OF MAIZE PRODUCTION

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ABSTRACT
In our investigation, we used different weed control technologies in the different phenology states of the maize. The farm experiment has been carried out in 2017, in Hungary, Kunágota, on good quality chernozem soil, on 20 x 50 m plots. The experiment can be regarded as 9 weed-control strategies where, in addition to the untreated control, two chemicals are applied (Laudis, Capreno) in different doses, two mechanical weed-control technologies, and two combination of chemicals and mechanical weed-control technologies were used. Mechanical weed-control was connected to the herbicide treatments in different times: until 4-6-leaves age weedless, in 4-6-leaves age hoed once, in 4-6-leaves age cultivation once. In our farm experiment, there were assessed the number of plants, length of plants, leaf number of maize, corncob-number, corncob-length, line number of corncob, thousand seed weight yield and profitability of maize production.
Our results were evaluated by a one-factor analysis of variance. Our one-year weed control experiment show that Capreno performed better, than Laudis with respect of plant height, number of leaves, length of corn-cob, number of lines of corn-cob, thousand seed weight and yield. By increasing the dose of Capreno, all the tested values of crop elements degraded except for plant height, so the crop yield also decreased.

Keywords: maize, weed-control, yeald components, profitability

INTRODUCTION

The maize is one of the most important arable crops in Hungary and in the World. The extreme weather conditions of the last years in Hungary pointed out that the farmers need to adapt to changing terms by the help of agrotechnical factors. The late years' economical, climate and the cultivar changes gave new jobs to agrotechnique researches in Central Europe.
Weeds mean one of the most important problems in maize fields. We can protect against weeds with prevention (BERZSENYI, 1988), with agrotechnical methods (ALKÄMPER, 1976; KOVÁCS, 1992; KISMÁNYOKI, 1994; ANTAL, 2005; RACSKÓ, 2004), with mechanical methods (HUNYADI ET AL., 2000.) with chemicals methods (NAGY, 2007; REISINGER, 2010; GYULAI ET AL., 2016; KAZINCZI, 2016) or with combination of these. The change of method is one of the most important problem in the weed-control for farmers. The aim of our study is to compare the effects of the different weed control technologies on the yield components, the yield and profitability of maize.

MATERIAL AND METHOD

The experiments were carried out in Békés county, Kunágota, in 2017 on good quality, homogeneous, flat surface chernozem soil. Sunflower was the forecrop of our farm

experiment. The sunflower forecrop was sprayed with Pulsar. 54 kg ha^{-1} N active agent was emitted in springtime. The sowing was done with Dekalb DKC 5275 maize hybrid, on 5 April 2017, with 70.000 seeds m^{-2} amounts of seeds, interline spacing was 75 cm. The research was established farm conditions on 20 x 50 m plots. *Table 1* shows the applied weed-control technologies in the experiment.

Table 1. Weed-control technologies in the experiment

Treatments	Rate (l ha^{-1})	Mode of application
1. untreated control		all the time weedy
2. mechanical weed-control		in 4-6-leaves age hoed once
3. mechanical weed-control		until 4-6-leaves age weedless
4. Laudis	2	postemergence (in maize 4-6-leaves age)
5. Capreno	0.4	postemergence (in maize 4-6-leaves age)
6. Capreno	0.3	postemergence (in maize 4-6-leaves age)
7. Capreno	0.2	postemergence (in maize 4-6-leaves age)
8. Laudis	2	postemergence (in maize 4-6-leave age) + in 4-6-leaves age cultivation once
9. Capreno	0.3	postemergence (in maize 4-6-leave age) + in 4-6-leaves age cultivation once

Table 2 contains the meteorological data during the time of the experiment.

Table 2. Meteorological data during the experiment

Months	Decade	Average temp. (°C)	Precipitation (mm)
April	1.	12.25	10
	2.	9.3	22
	3.	12.1	4
May	1.	15.35	6
	2.	18.25	20
	3.	19.18	20
June	1.	21.25	16
	2.	21.18	7
	3.	25	13
July	1.	23.7	1
	2.	22.9	11
	3.	23.86	31
August	1.	27.75	14
	2.	23.85	18
	3.	21.31	0
September	1.	20.27	35
Total			**228**

During our field test, in four replications, we determined area unit of number of plants, height of plants, number of corn-cob, number of leaf of plant, length of corn-cob, number of line of corn-cob, number of seeds of line, thousand seed weight and the yield. We calculated all expense, return and profit of maize production.

RESULTS

Table 3 shows the effect of weed-control technologies on yield components of maize. *Figure 1* shows the effect of weed-control technologies on yield weight of maize.

Table 3. The effect of weed-control technologies on yield components of maize

Yield component	1.	2.	3.	4.	5.	6.	7.	8.	9.	$SzD_{5\%}$
height of plant (cm)	190.31	192.31	248.84	242.75	245.89	244.67	248.53	242.71	241.59	13.55
number of plants (pc)	5.38	5.13	5.63	5.5	4.88	5	5.13	5.38	5.5	0.5
number of corn-cob of plant (pc)	1	1.05	1.11	1.2	1.05	1.13	1.15	1.21	1.09	0.16
number of leaves of plant (pc)	10.50	10.90	11.20	10.70	10.50	10.80	11.10	10.9	11	0.58
length of corn-cob (cm)	10.73	18.52	19.31	18.26	17.96	18.79	17.96	19.2	18.02	1.91
number of line of corn-cob (pc)	13.75	17.39	17.3	17.34	17.91	17.98	18.18	17.57	17.37	0.33
number of seed of line (pc)	17.97	35.1	36.79	34.83	33.88	34.64	33.73	34.85	32.91	4.46
thousand seed weight (g)	212.5	277.5	310	270	285	295	272.5	272.5	272.5	31.53

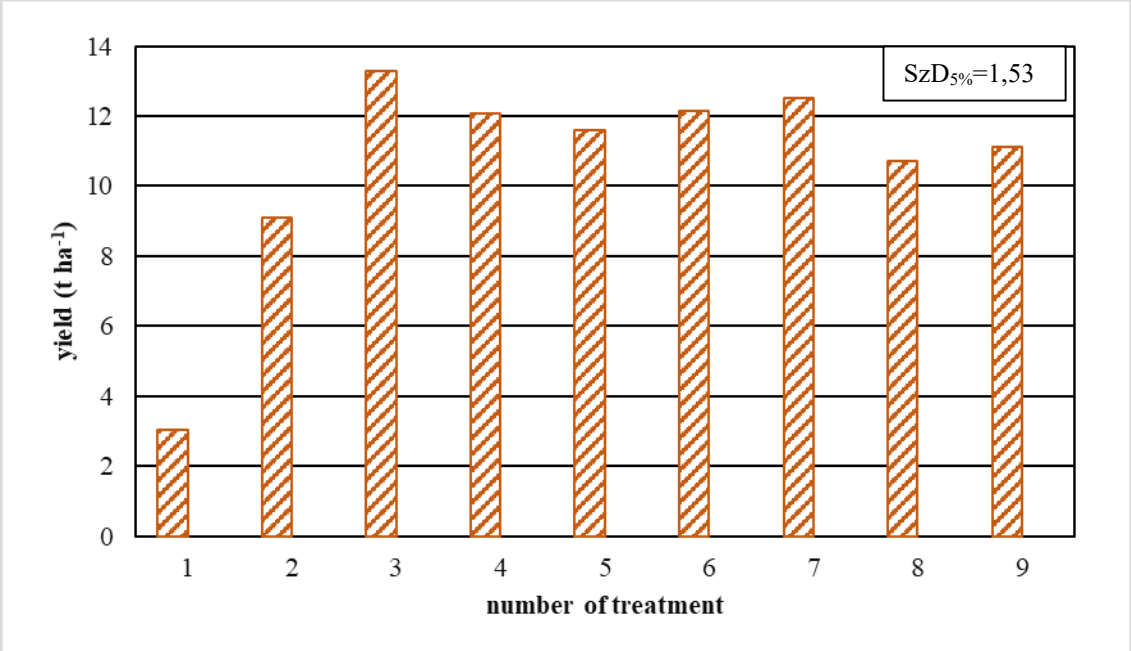

Figure 1. The effect of weed-control technologies on yield weight of maize

Table 4 contains the constant expense, variable expense, total expense and return of examined weed-control technologies on of maize production. *Figure 2* shows the effect of weed-control technologies on the profit of maize production.

Table 4. The effect of weed-control technologies on expense and return of maize production

Expense and return data	1.	2.	3.	4.	5.	6.	7.	8.	9.
Constant expense (Ft ha^{-1})	100650	100650	100650	100650	100650	100650	100650	100650	100650
Variable expense (Ft ha^{-1})	0	35000	175000	20057	25975	13660	19818	22388	22388
Total expense (Ft ha^{-1})	100650	135650	275650	120707	126625	114310	120468	123038	123038
Total return (Ft ha^{-1})	127260	382620	557760	507780	486780	509880	525840	449820	467040

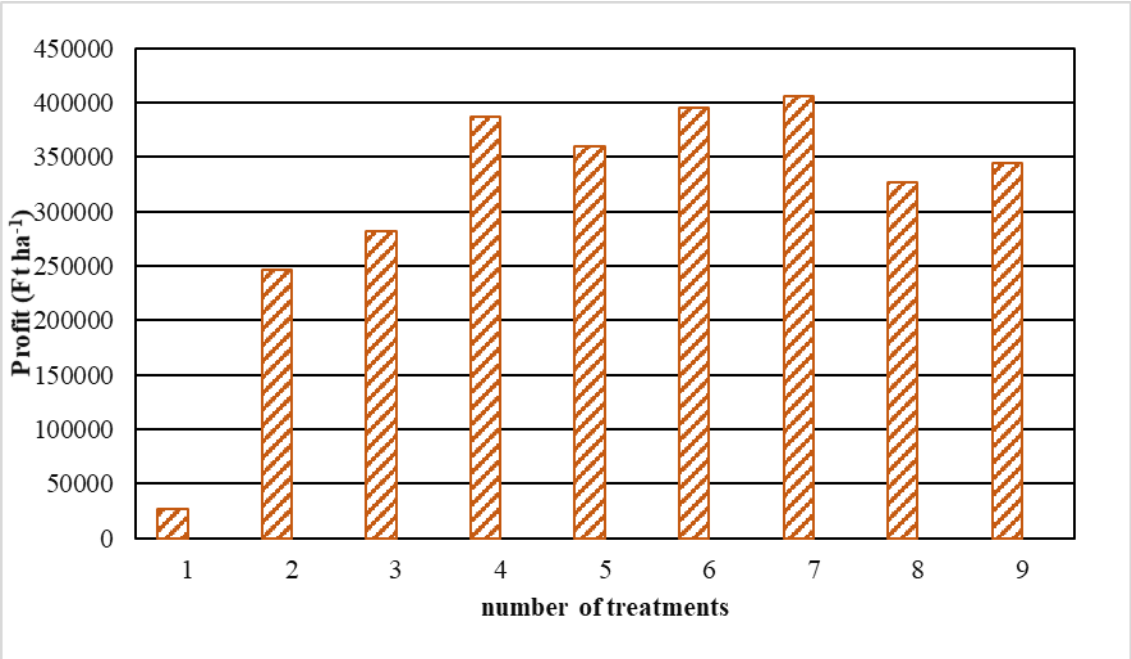

Figure 2. The effect of weed-control technologies on the profit of maize production

CONCLUSIONS

Capreno performed better than Laudis with respect of plant height, number of leaves, length of corn-cob, number of lines of corn-cob, thousand seed weight and yield. By increasing the dose of Capreno, all the tested values of crop elements degraded except for plant height, so the crop yield also decreased. With regard to the profitability of our one-year weed control experiment, it can be stated that the lowest profit was in the case when weeds were all the way through, but there were hardly any differences in the profitability of chemical treatments per hectare.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

EFFECTS OF DIFFERENT CASING ONTO THE YIELD OF BUTTON MUSHROOM

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ABSTRACT
In Europe and Hungary *Agaricus bisporus* is the most widely cultivated mushroom. Because of the competition on the market and the increasing costs of production is necessary to optimize the cultivation conditions and develop its intensive production technologies. The casing of the substrate is a critical and essential part of the intensive cultivaion technologies. The casing layer is important because it helps to protect the substrate from some pathogens and also balances the alternating temperature. More than 90% of the button mushroom fruitbody is water and thus mainly supplied by the casing. This casing soil contains the essential microbiota for primordia formation like *Pseudomonas putida* which has an important role in pin head stage. Casing soils origine from different source, mainly bogs or fens. The major component of casing soil is usually some kind of peat, like Sphagnum peat or black peat and lime. There is many contradiction about the effect of this casing soils onto the mushroom production during cultivation. In this study, we collected 7 different casing soils from farmers and casing soil producers (1 Dutch, 2 Polish, 2 Romanian and 2 Hungarian) and monitored the changes of its electric conductivity (EC) and pH during a small-scale cultivation, and examined this casings effects onto the yield. According our experiment the pH had been decreasing and the electric conductivity had been increasing during the cultivation. There were no significant differences between the casings in the total yield, but our results underlined that quality of casing has a major importance in the mushroom cultivation.

Keywords: casing soil, *Agaricus bisporus*, electric conductivity, pH, yield

INTRODUCTION

In the last decades the mushroom production in the World increased dramatically, significant jump was observed in the last 10 years. The mushroom production worldwide growth is over 27 million tons/year. It means that average mushroom consumption has been increased from 1 kg/capita to 4 kg/capita/year. The most widely cultivated mushrooms are *Agaricus spp.* These take a part of 30% of the world's mushroom production (ROYSE, 2014). In Europe and Hungary the commonly cultivated mushroom species is *Agaricus bisporus*. In our country the share of the species is around 92% (FRUITVEB, 2015). On one hand, the increasing amount of production on the other hand the cultivation costs and competition on the market underline the importance of optimalization of the growing technology.
In button mushroom (*Agaricus bisporus*) cultivation an important step is the casing of the substrate, because of several reason. The fruit bodies of button mushroom contain about 90% of water and this is mainly provided by the casing layer. Growing of the mycelium is positively infulenced by the high CO_2 concentration that is also served by the casing material (ERDEI, 1999). This substrate is also a reservoir for the microbiota, like *Pseudomonas putida* which has an important role in pin heading stage (COLAUTO ET AL., 2016; OUDEN, 2016). Casing layers can protect the substrates against some patogens and dramatic temperature changing as well.

In Europe, casing soils are usually made from mixed peats and lime, but peats are origin from very different places, like bogs and fens. These areas are serving different peats, like black peat or Sphagnum in different quality. We have some practical knowledge about the optimal casing, but there is a lack of information about its general quality and effects on the button mushroom yield. We would gather information about this phenomenon because we will run out of peat needed for mushroom production and we should find some potential material to replace it.

MATERIAL AND METHOD

In this study, 7 different casing soils originating from different countries were collected: 1 Dutch, 2 Polish, 2 Romanian and 2 Hungarian type of material were tested. A small scale cultivation experiment was conducted by using Phase 3 (bulk-colonized) compost. The 7 different casing soils were placed on the compost in 5 cm thickness and 8 replicates were used. The compost bags were placed in a growing a room as a block design. The crop rurned for 35 days and casing samples were taken on every 5th days. Its pH and EC (electric conductivity) were measured by Hanna Instruments HI 2550 pH/ORP & EC/TDS/NaCl Meter. The yield achieved on different casings were also noticed, by measuring the fruit body weight on each picking day.

RESULTS

Electric conductivity (EC)

During the cultivation, the EC level was measured as it shown on *Figure 1*. On this graph the curve of EC can be seen. We concluded that initial value of the casing soil might be important because high deviation depending on origin was detected.

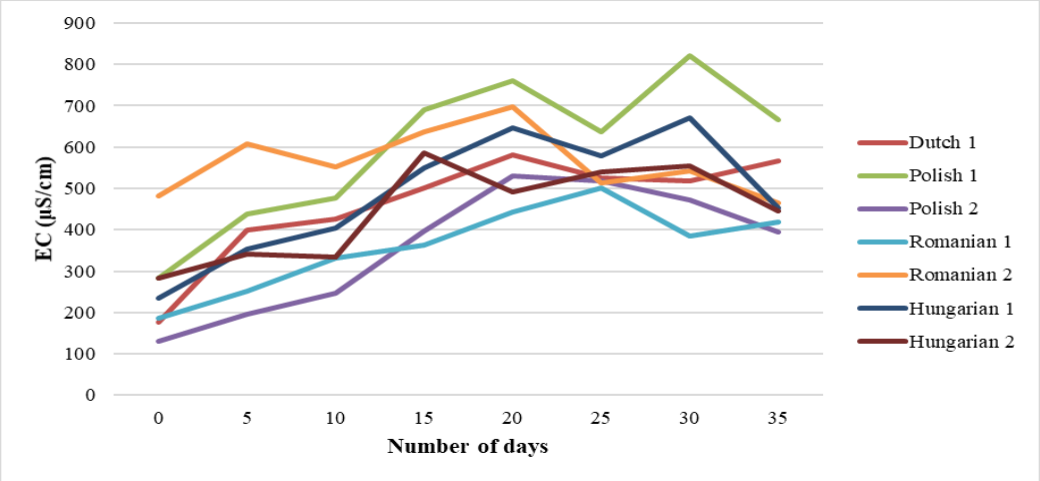

Figure 1. Monitored EC under cultivation

In the first part of the cultivation, the Polish 2 casing had the lowest EC (130,5 µS/cm) and the Romanian 2 had the highest one (481,5 µS/cm). These values did not reach the 1000 µS/cm level in the first days of the cultivation, wich has influence on the yield according to AHDB (2011). During the cultivation, the electric conductivity increased slowly. At the end of the cultivation the highest value was shown by Polish 1 casing soil (666 µS/cm) and lower level was shown by Polish 2 (394 µS/cm) casing material. The final EC value of the

casing materials did not reached the critical value so from this point of view the casings are fine.

pH level

The value of pH was also measured during the cultivation. It is shown in *Figure 2*. At the begining of the cultivation, pH levels of the casing soils were above 7. The Dutch 1 had the highest pH (7.66), but Romanian 1 had almost the same (7.65). The Hungarian 1 had lower level (7.04). Most of the literature suggests that optimal pH for mycelia growing is between 7.5-7.6 (JARIAL ET AL., 2005; GYŐRFI, 2010). The farmers should pay attention to keep the pH value above 7 because under 7 there is a more sensitive environment for *Trichoderma spp.* infection (OUDEN, 2016). Unfortunately, the pH of each casing soils drop under 7 on the 10th day of cultivation. It may explain why are there more infections at the later stages of button mushroom cultivation.

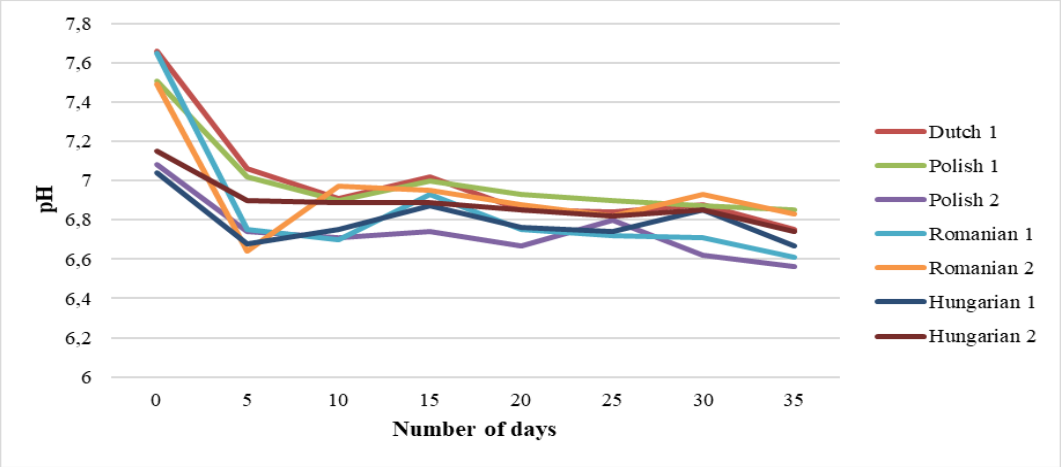

Figure 2. Changing of pH under cultivation

Yield of the Cultivation

In the course of the 35 days of cultivation we checked the development of mycelia and picked the mushroom fruitbodies daily. First mushrooms appeared between 18th and 21th days of the cultivation. On *Figure 3* the aggregated yield can be seen. The average yield of the different casing soils was very similar meaning that basically there was no difference between the fruit body production of the different casing soils.

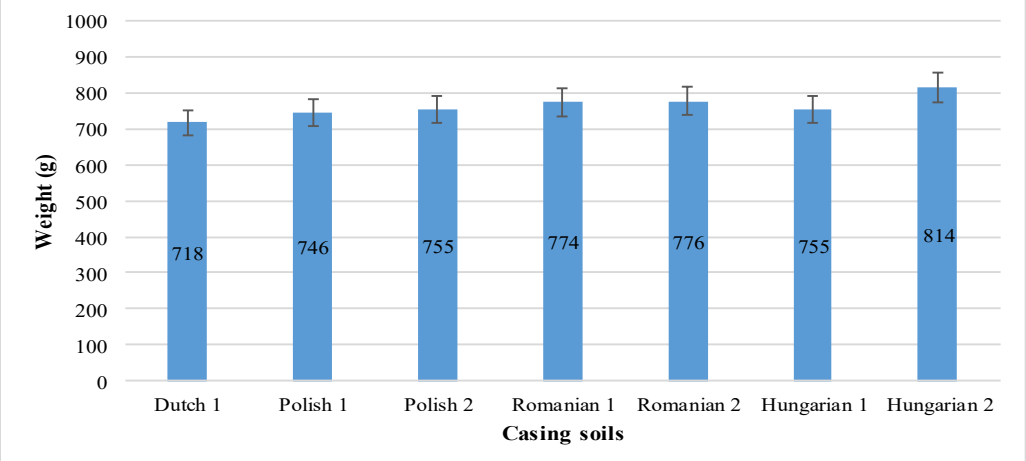

Figure 3. Average yield of different casings

CONCLUSIONS

Casing soils used in mushroom cultivation may originate from very different places and their components are very heterogeneous, but mainly contain peats and lime. Although their quality is an important factor of successful cultivation, we do not have enough information about the casings wich are used in cultivation.
According to our results, starting EC values of casing soils are different, but they are between 100-500 µS/cm. During the cultivation EC is increasing, and at the end of the cultivation usually does not reach the 1000µS/cm value. The highest value was 666 µS/cm. According to the report of AHDB (2011), the critical value is 1000 µS/cm. Other researches found that EC is suitable for mushroom cultivation to 5000 µS/cm, it will only delay pinheading and the development of mushrooms (OUDEN 2016).
Values of pH are still very different in csaing soils. These fluctuate between 7.04 and 7.66. According to literatures, optimal pH values are between 7.5-7.6 (GYŐRFI, 2010). During the cultivation pH is decreasing under 7, in our study the lowest value was 6,56. The falling pH is in correlation with the added lime because, it is used to increase and stabilise the pH. A further study is needed that target constant pH by alkaline watering and examine the effect on the yield and the rate of infections, mainly over the first flush.
Focusing on yield there was no significant diference between the casing soils. According to our study, all the tested casing soils were suitable for button mushroom cultivation.

ACKNOWLEDGEMENTS

We would like to say thank you, for the helping hands to Mariann Füri, and all the other people who helped in the mushroom picking. Also thank you for the casing soil donates.
Supported by the ÚNKP-17-2 New National Excellence Program of the Ministry of Human Capacities.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

RELATIONSHIPS BETWEEN REPRODUCTION PARAMETERS IN DAIRY COWS

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ABSTRACT
The aim of the reproductive management of dairy farms is to keep low the days in milk (DIM). Milk production can be profitable only in that case. Calvings make only low DIM. From the economic point of view, to evaluate the amount of the calving is not simple because in many cases the insemination and the calving are not in the same year. We wanted to find a reproduction parameter, which is easy to record, available real time, and corrrelate well with other parameters. We collected reproduction data from 21 farms from 2016. Average numbers of cows, number of the ai (artificial insemination) in cows, number of cows pregnancies, open days (OD), service period (SP), time of first ai (TFAI), conception rate of first ai (CRFAI), conception rate of all ai (CRSAI) were collected. The number of the pregnant cows were grouped, pregancies under 120 days after calving -U120- and pregnancies above 200 -A200- days after calving. The economical effect of open days are well-known. OD correlated with the rate of the pregnancies under 120 days after calving ($r = -0.802$; $P \leq 0.001$). The open days correlated with the rate of the pregnancis above 200 days after calving ($r = 0.889$; $P \leq 0.001$). If the rate of U120 is high, the rate of pregnant cows (ROPC) will be high too ($r = 0.611$; $P = 0.003$). A200 is in negative relation with ROPC ($r = -0.525$; $P = 0.015$). OD correlated with TFAI ($r = 0.562$; $P = 0.008$). ROPC correlated with TFAI ($r = -0.457$; $P = 0.037$). OD correlated with SP ($r = 0.778$; $P \leq 0.001$). SP is in negative correlation with CRFAI and CRSAI ($r = -0.577$, $P = 0.006$; $r = -0.773$, $P \leq 0.001$). SP correlated with U120 and A200 ($r = -0.572$, $P = 0.007$; $r = 0.788$ $P \leq 0.001$). Our study shows that the rate of the pregnant cows are stasistically correlated with many important reproduction parameters. The measurement of the number of pregnant cows is easy, available real time and it has important economical effect on milk production. In summary, the number of pregnant cows is a useful parameter to evaluate the reproductive performance and current status of the farms.

Keywords: DIM, number of pregnancies, correlated, reproduction parameters

INTRODUCTION

Many parameters help to evaluate repdroduction performance. These parameters are connected to the oestrus cycle and the lactation stadium. The calving interval, oped day, conception rate, pregnancy rate, sevice period, calving rate, number of services, sevices per conception, non-return rate, productivity, first sevice conception rate, days to first service (ZÖLDÁG AND HARASZTI, 1994; PLAIZIER ET AL., 1998; KOVÁCS ET AL., 2010; FODOR AND ÓZSVÁRI, 2015) can be used to assess reproduction performance. KRAJNEC ET AL. (2015) evaluate many reproduction parameters.
Milk production can only be profitable with low days in milk (DIM). The aim of the reproductive management is to keep low DIM of dairy farms (RIBERIO ET AL., 2012). In fact, calvings make only low DIM. From the economic point of view, to evaluate the amount of calving is not simple because in many cases the insemination and the calving are not happening in the same year. Previously, open day and calving intervall were used to evaluate reproduction from the ecomonical pont of view (ÓZSVÁRI AND KERÉNYI, 2004).

MATERIAL AND METHOD

We collected reproduction data from 21 farms from 2016. All of the farms are located in Hungary. They have different sizes with different milk production levels. They use different reproduction technologies. All of these farms use RISKA farm system. Average numbers of cows, number of the ai (artificial insemination) in cows, number of cows pregnancies, open days (OD), time of first ai (TFAI), conception rate of first ai (CRFAI), conception rate of all ai (CRSAI) were collected for the study purposes. From these data, service period was calculated by our study group (open day – time of first ai = service period). The average number of cows was calculated by RISKA software. The numbers of the pregnant cows were grouped according to the followings: pregnancies under 120 days after calving -U120- and pregnancies above 200 -A200- days after calving. Pregnancies were correlated to the average number of cows (*Table 1*). Correlation between reproduction parameters were evaluated by SPSS statistical software package.

RESULTS

In the daily routine, there are some possibilities to create good reproduction parameters in the dairy farms. If only the heating cows are selected (for condition, heating intensity) some parameters predict a well functioning, while the number of pregnant cattles are still low. In our data, there is a farm (farm 18) with relatively decreased OD (124 days) but on the ohter hand, the farm had low rate of pregnant cattles (for example: 62.9%). The same phenomena could happen with the CRSAI and CRFAI values (see farm1) (*Table 1*).

Table 1. Basic data

	ROPC	OD	TFAI	SP	CRFAI	CRSAI	U120	A200
farm1	66.6	157	97	60	32.7	33.2	42.0	23.7
farm2	79.4	124	66	58	31.6	30.6	64.3	13.1
farm3	78.6	129	71	58	30.8	30.5	59.7	13.8
farm4	74.8	129	71	58	30.3	31.8	57.9	15.6
farm5	75.9	141	68	73	30.1	30.5	52.9	20.1
farm6	72.8	121	67	54	29.2	28.4	62.3	12.5
farm7	70.7	128	74	54	28.1	31.1	51.9	15.9
farm8	64.6	157	89	68	27.9	28.6	44.3	22.7
farm9	58.1	129	71	58	26.4	30.3	54.3	17.2
farm10	71.9	151	79	72	22.8	23.0	49.4	19.5
farm11	62.5	186	85	101	22.4	21.4	41.1	33.7
farm12	72.2	153	66	87	21.3	23.9	48.9	23.6
farm13	84	116	50	66	21.2	26.5	63.1	12.4
farm14	72.9	163	61	102	21.0	20.3	48.1	26.7
farm15	73.6	159	73	86	20.6	25.3	42.8	27.9
farm16	69.8	156	62	94	20.8	19.6	50.9	23.9
farm17	72.6	126	58	68	18.6	22.7	59.2	14.9
farm18	62.9	124	59	65	18.0	22.8	51.4	21.0
farm19	60.8	152	73	79	17.7	21.3	36.8	30.6
farm20	72.9	147	65	82	15.6	20.0	41.8	28.2
farm21	72.4	129	53	76	13.8	20.7	51.2	17.6

Open days and conception rate are not able to evaluate the reproduction performance well. The economical effect of open days are well-known. The change of open days with any number of days has significant economical effect. OD correlated with the rate of the pregnancies under 120 days after calving (r = -0.802; P ≤ 0.001) (*Table 2*).

Table 2. Correlation between OD and U120 and A200

		OD	U120	A200
OD	Correlation	1	-.802**	.889**
	Sig. (2-tailed)		,000	,000
	N	21	21	21
U120	Correlation	-.802**	1	-.920**
	Sig. (2-tailed)	.000		.000
	N	21	21	21
A200	Correlation	.889**	-.920**	1
	Sig. (2-tailed)	.000	.000	
	N	21	21	21

** Correlation is significant at the 0.01 level (2-tailed).

The open days correlated with the rate of the pregnancies above 200 days after calving (r = 0.889; P ≤ 0.001).
If the rate of U120 is elevated, the rate of pregnant cows (ROPC) will be increased too (r = 0.611; P = 0.003) (*Table 3*).

Table 3. Correlation between U120 and ROPC and A200

		U120	A200	ROPC
U120	Correlation	1	-.920**	.611**
	Sig. (2-tailed)		.000	.003
	N	21	21	21
A200	Correlation	-.920**	1	-.525*
	Sig. (2-tailed)	.000		.015
	N	21	21	21
ROPC	Correlation	.611**	-.525*	1
	Sig. (2-tailed)	.003	.015	
	N	21	21	21

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

A200 is in negative relation with ROPC (r = -0.525; P = 0.015). If there are many pregnant cows in the farm, the number of pregnant cows above 200 days from calving is decreased. OD correlated with TFAI (r = 0.562; P = 0.008) (*Table 4*).

Table 4. Correlation between OP and TFAI

		OD	TFAI
OD	Correlation	1	.562**
	Sig. (2-tailed)		.008
	N	21	21
TFAI	Correlation	.562**	1
	Sig. (2-tailed)	.008	
	N	21	21

** Correlation is significant at the 0.01 level (2-tailed).

To achieve low OD, the AI should be as close as possible to the calving period. ROPC correlated with TFAI (r = -0.457; P = 0.037) (*Table 5*).

Table. 5 Correlation between TFAI and ROPC

		TFAI	ROPC
TFAI	Correlation	1	-.457*
	Sig. (2-tailed)		.037
	N	21	21
ROPC	Correlation	-.457*	1
	Sig. (2-tailed)	.037	
	N	21	21

* Correlation is significant at the 0.05 level (2-tailed).

To achieve a higher number of pregnant cows, the first AI should be started as soon as possible. OD correlated with SP (r = 0.778; P ≤ 0.001) (*Table 6*).

Table 6. Correlation between SP and OD

		SP	OD
SP	Correlation	1	.778**
	Sig. (2-tailed)		.000
	N	21	21
OD	Correlation	.778**	1
	Sig. (2-tailed)	.000	
	N	21	21

** Correlation is significant at the 0.01 level (2-tailed).

The low SP means that, the cattle become pregnant in a very short period of time. SP is in negative correlation with CRFAI and CRSAI (r = -0.577, P = 0.006; r = -0.773, P ≤ 0.001) (*Table 7*).

Table 7. Correlation between SP and CRFAI and CRSAI

		SP	CRFAI	CRSAI
SP	Correlation	1	-.577**	-.773**
	Sig. (2-tailed)		.006	.000
	N	21	21	21
CRFAI	Correlation	-.577**	1	.903**
	Sig. (2-tailed)	,006		,000
	N	21	21	21
CRSAI	Correlation	-.773**	.903**	1
	Sig. (2-tailed)	.000	.000	
	N	21	21	21

** Correlation is significant at the 0.01 level (2-tailed).

The SP can only be short if the conception rate is favourable. SP correlated with U120 and A200 (r= -0.572, P = 0.007; r = 0.788 P ≤ 0.001) (*Table 8*).

Table 8. Correlation SP and U120 and A200

		SP	U120	A200
SP	Correlation	1	-.572**	.788**
	Sig. (2-tailed)		.007	.000
	N	21	21	21
U120	Correlation	-.572**	1	-.920**
	Sig. (2-tailed)	.007		.000
	N	21	21	21
A200	Correlation	.788**	-.920**	1
	Sig. (2-tailed)	.000	.000	
	N	21	21	21

** Correlation is significant at the 0.01 level (2-tailed).

There are many pregnant cows under 120 days from calving when the SP is low.

CONCLUSIONS

Our study shows that the rate of the pregnant cows are statistically correlated with many important reproduction parameters. The measurement of the number of pregnant cows is simple, available real time and it has important economical effect on milk production (correlation open days). In summary, the number of pregnant cows is a potentially useful parameter to evaluate the reproductive performance and current status of the farms.

ACKNOWLEDGEMENTS

We are thankful for the Management of the farms and Margit Szabari MD PhD from Harvard Medial School, Massachusetts General Hospital for their help.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

CERTAIN PARASITOSIS OF THE WILD BOAR AND THEIR IMPORTANCE IN WILDLIFE MANAGEMENT IN HUNGARY AND IN CERTAIN HUNTING REGIONS OF HEVES COUNTY

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ABSTRACT
The authors examined coccidia infection of fecal of wild boars shot in the south region of Mátra in Hungary. All animals were harvested in the 2009-2011 hunting season.
Seventy one (43.82%) positive results were found out of 162 wild boars tested for coccidia oocyst. The *Eimeria spp.* were indentified in 44 cases and *Eimeria perminuta* in 41 cases (93.18%), *E. debliecki* 21 cases (47.72%), *E. scabra* 11 cases (25.0%), *E. neodebliecki* 6 cases (13.63%) were found. In case of the wild boars that were younger than 1-year-old 21 positive samples (29.57%) were found and in case of older than 1-year-old wild boars, 50 (70.42%) animals were tested positively. The coccidia oocyst infection occoured more frequently in case of males- 42 (59.16%) were tested positivley- as for the females 29 (40.84%) positive samples were found. Based on the results, even co-infection between Eimerias and helminths can be assumed.

Keywords: *Sus scrofa*, wild boar, parasites, *Eimeria*, Metasrongilosis, Trichuriosis

INTRODUCTION

The wild boar stock has significantly increased recently in Hungary (*Table 1*).

Table 1. The wild boar stock in Hungary (1960-2015)

Year	Estimation	Yearly bag
1960	8 300	3 900
1970	15 669	8 992
1980	20 397	20 241
1990	38 826	46 672
2000	76 054	67 745
2010	106 734	112 381
2015	105 654	137 101

This fact has got financial and veterinary health significance. The rising number of wild boars is increasing the financial income of the hunting club. In addition to this, it provides a cheap hunting opportunity for the majority of national hunters. At the same time, the damage caused by wild boars may also increase. This is the reason, why the reduction led to establishing of „wild boar" game gardens, in which there is a big demand for driven hunting.
In veterinary health point of view, we should consider the following fact that a strain sow gives birth to 7–8 piglets on average but half a year later she raises only 3–4 pigs. The bulky type of species usually are of K-strategists, despite the significant mortality detected among them. It's also true that among the highly productive species there is a higher number of offsprings, which is the part of r-strategy, which is a compensation for later mortality. The mortality can be caused by the lack of food, predators' effect, or just illnesses. Besides viral and bacterial diseases parasitosis also plays an important role

(FERNANDEZ DE MERA, 2003; ILIC, 2011). Even prevention is possible against the above mentioned diseases, especially in game gardens (ÁKOSHEGYI, 1997).
That's the reason, why I focus on the endoparasita examination of wild boar stock in the test area. Among them primarily ones, the coccidiosis and helminths were examined.

MATERIAL AND METHOD

The fecal samples were collected from Hatvan, Gyöngyös district in Heves county mainly from the Mátra mountains and its region. Altogether, 163 specimen have been collected and examined. Sampling has been done between 2009 and 2011, when classical pig plague took its tools in this region. During this time we tried to eliminate epidemic with administrative measures, which requested hunters to deliver each shot boar's blood sample and tonsils to the District Chief Veterinarian's office. It gave me the idea to ask for recent faeces from the rectum. The samples from boar were identified by the same number as the number identifying the body. It was written on the sampling sheet attached to the sample. On the sampling sheet the following data can be collected:

- big game identification number
- name and address of the authorized hunter
- the harvested place according to GPS
- the time of shooting
- the sex of animal
- the age of animal
- body weight after evisceration.

The samples avoided being frozen, were sent to the former Parasitology and Zoological Department Faculty of Veterinary Medicine of Szent István University. The examinations were performed on in two directions. On the one hand, we were looking for cell parasites, first of all, coccidias, on the other hand, the intestinal parasites' ovums.
At the university, the detection of oocysts of coccidim was performed by surface enrichment method for which Breza kind of enrichment liquid was used. The grams per definition of the samples were performed by McMaster method (KASSAI, 2011). To identify sporulated oocysts, identifier was used. In the first 54 cases of 163 samples species typing and quantitative examination have not been performed just the detecting of the presence or lack of different kinds of parasite species. 163 wild boars giving samples were fifty-fifty per cent 82 females and 81 males.
The number of wild boars under one year is 37, and 126 is the number of older ones. The age estimation of the older animals under 1 year is usually random, it gives possibility to make a mistake, that's why we did not distinguish them by age, although the hunters gave the animals' estimated age on the survey sheet.

RESULTS AND DISCUSSION

Out of the 163 stercoraceous samples 71 oocysts were found. In 44 cases species definition has been done (*Table 2*).

In 93.18% per cent (41 cases) *Eimeria perminuta*
47.72% (21 cases) *Eimeria debliecki*
25% (11 cases) *Eimeria scabra*
13.63% (6 cases) *Eimeria neodebliecki* has been detected.

Out of 44 samples in 45 per cent (20 samples) one type of infection
in 27.27% (12 case) two types of infection
in 22.72% (10 case) three types of infection occur.
in 4.54% (2 cases) four different types of infection occured in the same species.

Table 2. Details of the original and result database (species: wild boar)

Identificion number	Under 1 year	Above 1 year	Sex	Origin	GPS coordinates	Time of harvest	Eimeria	Trichuris	Metastrongylida	Oesophagostomum	Other
2999		3 years 80kg	male	Domoszló-Kisnána	47,81774-20,09294	19-10-2011	1450		50		*E. neodebliecki E. perminuta E. scabra*
164247	9 months 18kg		female	Egererdő Zrt	714808-284066	07-01-2010		50			
164248	8 months 20 kg		female	Egererdő Zrt	714646-283968	07-01-2010	50		350		*E. perminuta E. scabra*
7851		2 years 65 kg	male	Szücsi	47,81050-19,72667	27-11-2010	750		50		*E. debliecki E. scabra E. perminuta*
9432	12 months 20 kg		male	Gyöngyös-tarján	710796-277063	30-11-2010	950	50	50		*E. debliecki E. perminuta E. neodebliecki*
2330		2 years 46 kg	male	Apc	47,81509-19,69079	29-11-2010	100				*E. debliecki E. perminuta*
4890		4 years 97 kg	male	Egererdő Zrt	710997-282533	04-12-2010	550			100	*E. debliecki E. perminuta*
4878		15 months	male	Egererdő Zrt	710997-285995	04-12-2010	100		50		*E. perminuta*
7027		2 years 32 kg	male	Lőrinci	47,7480-19,7136	05-12-2010	50				*E. perminuta*
8531		4 years 40kg	male	Detk	47,768036-20,089034	12-12-2010	50				*E. debliecki*

The quantitative analysis showed significant difference as extreme value 50 and 3550 oocysts/1 g fecal saples. Infection has been detected in 59.16% of males and in 40.84% of females. Among the infected wild boars older than 1–year–old there were 31 males and 19 females. There was not any significant deviation among the males and females under 1–year–old.

I think both in national and international specialised literature the significance of *Eimeria* spreading in swines so in wild boars is not regarded as impotant as it should be. This is the parasite which the swine first meets since it gets into its organism from its mother's nipple — probably — this is one reason for premature mortality of pigs. The examination of premature pig mortality has a lot of difficulties, especially in the case of wild boar as these few-day-old animals can not be found due to cannibalism, predators' and scavengers' stomach. However, the few-day-old pigs are quickly weakened due to parasitic diarrhea and abdominal discomfort that can be fatal to them.

The other part of our examination focused on detecting helminth eggs. Within this, primarily we recieved data on nematode Metastrongilydae, *Trichuris suis*, Oesophagostomum infection. Our effort to detect *Ascaris suum* eggs was not successful as only one case has been detected.

The helminth eggs were determined at University of Veterinary Medicine by applying flotation method to which Breza kind of enrichment liquid was used. The quantitave determination was performed by McMaster method.

The results: out of 163 samples in 84 (51.53%) nematode eggs were detected.

In the most cases 72.61% the animals were infected only by one type of helminth egg, while in 23.8% by dual egg, in 3.57% three different helminth eggs were detected.

Among 37 species 26 (70.27%) under one–year–old were infected. Among the animals over one-year-old some kind of helminth eggs were detected in 58 animals.

Metastrongylus eggs causing lung worms were shown in 15 among under one–year–old species, while in the case of older animals in 44. Examining the sex distribution of the infection there is a slight difference: males are 47.45%, females are 52.54% are concerned.

Out of all samples in 26 (15.95%) *Trichuris suis* eggs have been detected. Within this in 11 cases (42.3%) under one–year–old, while in 15 cases (57.69%) more than one–year–old.

In sex distribution 16 males (61.5%) and 10 females (38.46%) were infected.

Oesophagostomosist causing focal colon helminth has been detected in 22 species (13.49%) (supposedly *Oesophagostomum dentatum*, but species determination has not been done).

Within this in 6 cases (27.27%) under one–year–old while in 16 cases (72.72%) more than one year.

In sex distribution Oesophagostomosis causing focal colon helminth has been detected in 13 males (59.09%) and 9 females (40.91%).

We also examined the correlation between the different helminth and altitude above sea level, but it did not show significant result. In the case of pneumonic helminth it was assumed that such a correlation could exist between Lumbricus terrestris as vector (BICSÉRDY ET AL., 2007) and thickness, quality of soil cover.

In summary, we can say that our results can fit into detected line of wild boar parasitosis in Hungary. In Mátra and its region similar research has not been done. Having regard the results the significance of parasites within cells, supposedly, is much higher than we would expect, especially in the case of young pig mortality.

In my opinion, the benefit of this research results is especially useful with the owners' of wild boar garden, as the owners have to anticipate with detected helminth infections either adopted or purchased wild boar stock. Protection against these infections can be done by giving the right type of antiparasitic treatment.

The benefit of this can be realizable in the quality of wild boars and in the number of the raised pig.

ACKNOWLEDGEMENTS

I would like to say thank you to the employee of Egererdő Ltd. Mátrafüred Forestry, who provided the samples. Thanks to Mónika Gyurkovszki from Parasitology Department of Veterinary Medicine, who helped me a lot with processing of samples. Lots of thanks to Miklós Heltai Dr. the tutor of the Wildlife Conservation Institute of Szent István University, who is my enthusiastic mentor. This presentation could not have been done without his assistance.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

ENHANCED BIODEGRADABILITY OF DAIRY SLUDGE BY MICROWAVE ASSISTED ALKALINE AND ACIDIC PRE-TREATMENTS

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ABSTRACT
Considering the rapid, volumetric and selective heating effects of microwaves the microwave assisted chemical methods could provide appropriate alternatives for conventional thermal methods in sludge processing. Microwave irradiation alone is suitable to accelerate the hydrolysis stage of anaerobic decomposition of sludge resulted in accelerated biogas production rate and in higher biogas yield. Alkaline pre-treatments increase the organic matter solubility and suitable for disintegration of sludge particles. In some study are concluded that acidic conditions help the disintegration of waste activated sludge and assist in the solubilisation of carbohydrates and proteins which led to increased higher biogas production, as well. Beside the promising results related to effects of microwave pre-treatments on anaerobic digestion of sludge there are very few reports on the investigation of combined acidic/alkali-microwave pre-treatment method for food industry originated sludge. Hence, our study focused on the examination of the effects of combined microwave-alkali and microwave-acidic pre-treatment on aerobic and anaerobic biodegradability of sludge produced in dairy industry
Our experimental results verified, that microwave irradiation with alkaline dosage improve the solubility of organic matters in the pH range of 8-12. But enhancement of disintegration was not correlated linearly with biodegradability. During pre-treatment stage, applying pH over 10, the aerobic biodegradability show decreasing tendency. Applying of acidic condition during microwave irradiation resulted in lower disintegration degree than obtained for microwave-alkaline sludge pre-treatment method. But with microwave assisted acidic pre-treatments a higher aerobic biodegradability could be achieved than with alkaline dosage. In microwave pre-treatments acidic condition was preferable to increase the shorter aerobic biodegradability; the alkaline condition was favourable to intensify the anaerobic digestion process.

Keywords: microwave, biodegradability, dairy sludge, pre-treatments

INTRODUCTION

Continuously increasing amount of sludge produced from municipal and industrial wastewater has been become one of the main practical problem for wastewater treatment plants. Among the stabilization methods anaerobic digestion (AD) is the main commonly used process. AD is suitable to reduce the amount of solids for disposal, mitigate the odour problems of sludge, other waste biomass can be handled co-digested with sludge, the final output stream, i.e. digested sludge, is beneficial for plant growth, and green energy is produced in the form of biogas (YANG ET AL., 2010).
In most cases efficient pre-treatment is need before AD to decrease the amount of aerobic microorganisms and make more susceptible the organic matters for biodegradation. Among possibly utilizable methods, the applicability of microwave irradiation prior to the AD has been investigated in the last decade. Microwave (MW) irradiation is an alternative method for the commonly used thermal treatment, in many cases is considered to be more effective than conventional heating methods (TYAGI AND LO, 2013). High energy intensity, volumetric heating effect and low loss of energy transmission led to rapid heating directly in the processed material. Change of dipolar orientation of polar side chains of macromolecules in electromagnetic field can manifest in unfolding of complex molecules,

or breakage of hydrogen bonds (AFOLABI AND SOHAIL, 2017). Application of thermal treatments can be limited by the denaturation for protein contented effluents and sludge. Heating time and temperature affects mainly the degree of denaturation, but the heat sensitivity of proteins is influenced by the pH and ionic strength, as well.

Because the chemical pre-treatments have also verified positive effect on biodegradability, combination of the two process category could be promising. In general, alkaline treatment, especially if it is associated by thermal methods, suitable to increase the disintegration, accelerate the anaerobic digestion and enhance the biogas production, as well (DOGAN AND SANIN, 2009). Compared to other methods, alkaline pre-treatments have many advantages, i.e. simple equipment, easy to operate and control, and high efficiency. Most of the investigations concluded increase in biogas producement and a decreasing tendency in volatile suspended solids concentration. On the other hand, it has also been concluded that sludge treatment at pH of 10.0 could inhibit the activity of methanogen bacteria resulted in higher volatile fatty acid production.

There can be found some studies where the efficiency of acidic sludge pre-treatments is investigated. DEVLIN ET AL. (2011) verified that pre-treatment of municipal WAS under acidic condition led to 4-6 times increment of carbohydrate and protein solubility, respectively. In batch mesophilic AD tests biogas production increased by 17% and 32% if acidic treatments were carried out at pH 2 and pH 1, respectively. Dosed acids reduce the negative charge of sludge particles interfere the forming of larger floc, therefore the ratio of bounded water closed into particles decrease, as well.

Combine the thermal and chemical sludge pre-treatments could be effective at lower temperature ranges considering the energy demand of pre-treatment process. It is verified that thermal pretreatments, applied them alone, at the temperature range below 100 °C was not sufficient to achieve the total degradation of complex molecules, but thermal effects were enough to induce deflocculation of macromolecules (PROTOT ET AL., 2011). Applying of thermochemical pre-treatments at temperature range of 70-90 °C enhanced of solubilization of proteins and increased removal of particulate carbohydrates can be observed (BESZÉDES ET AL., 2009). Combination of alkaline dosage with thermal treatment the surface area of sludge flocks increases and the organic substrates are more accessible to the anaerobic microbes. During thermos-alkaline treatment the effect of acidic components of sludge can be moderated via neutralization, which is advantageous considering the optimal pH range of AD. In acidic pre-treatments is needed to investigate the compounds of processed materials. Optimal pH of pre-treatments is depended on the isoelectric point in protein contented materials. A potential disadvantage of applying acidic condition during pre-treatments is the loss of fermentable sugar due to the increased degradation of the complex substrates.

Acidic and alkaline dosage affects the rate and the efficiency of biological degradation indirect way, as well, because the alkalization, or the neutralization after acidic pre-treatment is commonly carried out by using NaOH and/or KOH, respectively. Using of acid or alkali addition accompanying ions has been presented in sludge, therefore the theoretically high biodegradability of municipal and food industrial sludge is limited. It has been verified, that sodium ions in a concentration of above 5 g/L inhibit the anaerobic degradation, because the sodium is toxic to the bacteria utilizing the propionic acid. Anaerobic microbes are more tolerant to the potassium ion concentration, but over potassium concentration of 8g/L the anaerobic decomposition has been became inhibited. Lower inhibitory effect of potassium ions is observed over a concentration of 0.8 g/L, especially under thermophilic condition (KIM ET AL., 2000).

MATERIAL AND METHOD

Sludge samples processed by microwave pre-treatment originated from a dairy work. Dairy sludge has a total solid (TS) and chemical oxygen demand (COD) of 6.8 ± 0.3 w%, and 18900 ± 680 mg/L, respectively. Initial pH of raw dairy sludge was measured as 6.2 ± 0.3. Total solid content (TS) was measured by drying to constant weight at 105 °C. COD was measured by colorimetric standard method (APHA, 2005). Biochemical oxygen demand tests (BOD) were carried out in a respirometric BOD system (BOD Oxidirect, Lovibond, Germany) at 20 °C for 5 days.

Anaerobic digestion (AD) tests were carried out triplicated in continuously stirred laboratory scale reactors with volume of 250 mL equipped by Oxitop-C measuring head applying pressure operating mode (WTW GmbH, Germany). Seed sludge originated from an aerobic digester of the local municipal wastewater treatment plant. After microwave pre-treatments pH of the mixed sludge was adjusted to 7.6, temperature was thermostated at 37±0.2 ˚C for 30 days.

Microwave pre-treatment was carried out in a tailor-made microwave unit equipped with variable power magnetron (from 100 W to 850 W) operating at frequency of 2450 MHz. In the continuously flow operation mode the volumetric flow rate of irradiated samples can be varied by the revolution of peristaltic pump in the range of 6-35 L/h. The sludge was flow through a toroidal pipe in microwave unit. The specific irradiated microwave energy was determined as the product of magnetron power and residence time of processed material in the microwave unit. During the pre-treatments the pH of sludge was adjusted by NaOH and hydrochloric acid, respectively.

RESULTS AND DISCUSSION

In the first stage of the research the disintegration effect of microwave was investigated at different pH using different energy intensity. Disintegration degree was given by the ratio of organic matter measured by COD from soluble phase (SCOD) to the COD measured from total sludge matrix (TCOD). Our results show that at a given pH increasing of irradiated MW energy led to enhanced disintegration degree (*Figure 1*).

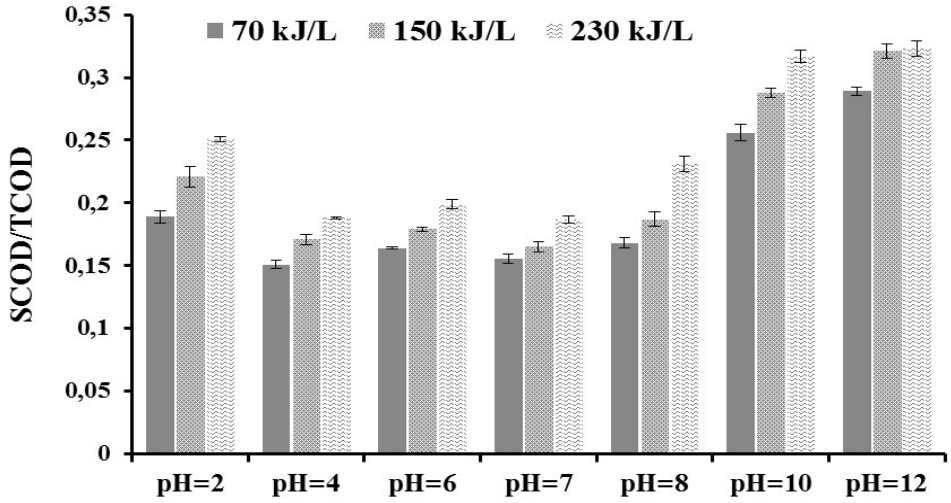

Figure 1. Ratio of soluble to total COD at different pH and irradiated energy levels

Considering the effect of pH adjusted for MW pre-treatment on disintegration degree can be concluded that compare to the treatment at neutral pH, acidic condition could increase the solubility of organic matters, especially if irradiated energy was set to higher level (230 kJ/L), but alkaline treatment assisted by microwave irradiation was more favourable. Initial SCOD/TCOD for raw dairy sludge was determined as 0.14, applied MW-alkaline treatment it is increased above 0.3 (*Figure 1*).

Disintegration degree is commonly used parameter to measure the efficiency of different sludge treatment processes. But biodegradability is not directly and linearly correlate with the change of organic matter solubility. Therefore, BOD measurements were carried out to determine the biodegradability of pre-treated sludge under aerobic condition. Considering the change of BOD it can be established, that though alkaline condition during MW irradiation could increase the aerobic biodegradability compare it to the MW irradiated sample at neutral pH, but applying acidic condition in MW treatment results in higher BOD (*Figure 2*). The initial BOD of raw sludge (6350 ± 390 mg/L) increased by near 90% if 230 kJ/L microwave irradiation was used at pH 2.

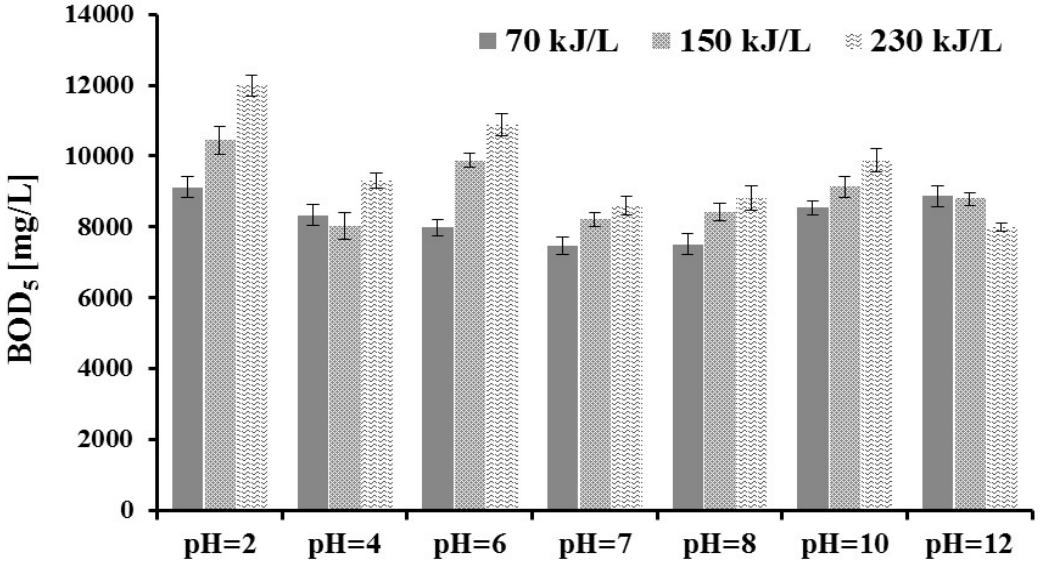

Figure 2. BOD at different pH and irradiated energy levels

It can be observed that the tendency of the change of BOD at acidic condition has been broken at pH 4, especially if energy intensity of MW irradiation was 150 kJ/L, and 230 kJ/L. This breaking point suggested to cause by the isoelectric point of casein, lactalbumin and lactoglobulin content of dairy sludge, which is the pH range of 4-5. It was also found, that by strong alkaline condition (pH=12) increasing of energy irradiation from 70 kJ/L to 230 kJ/L could decrease the biodegradability under aerobic condition (*Figure 2*).

For sludge utilization the anaerobic digestion processes are commonly used, mainly in mesophilic temperature range. Therefore, the biogas production of different pre-treated dairy sludge was also determined. Results related to biogas yield (given by the volume of produced biogas specified to gram dry matter of sludge) show unambiguously, that differ from the tendency observable for the change of aerobic biodegradability, alkaline condition applied during MW pre-retreatments of dairy sludge was more advantageous that acidic condition.

At every MW energy intensity level the biogas production of alkaline pre-treated samples were higher, than that of obtained for acidic pre-treated sludge. Compared to the biogas yield of raw sludge (152 ± 18 mL/g) the microwave assisted alkaline treatment enhanced the biogas production to above 300 mL/g (*Figure 3*).

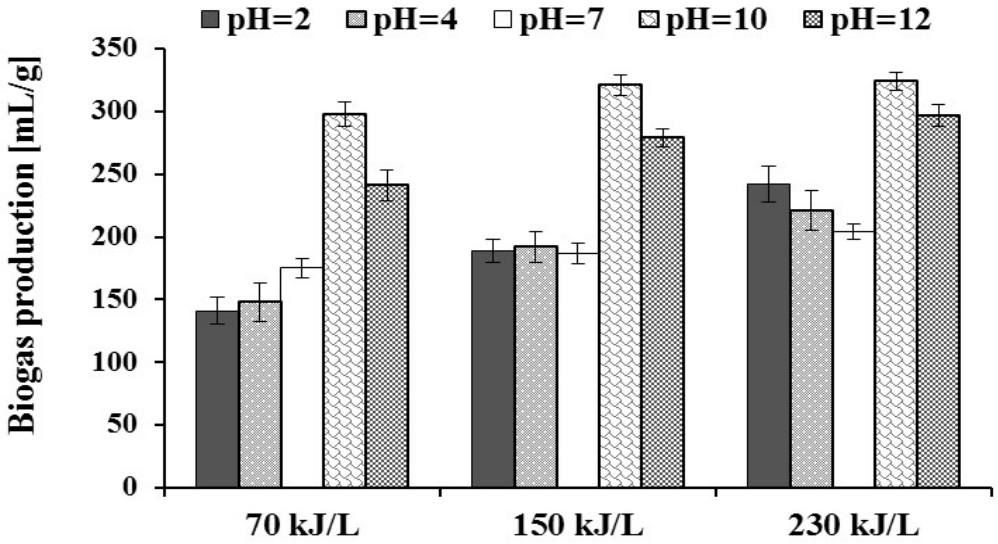

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Figure 3. Biogas production of pre-treated dairy sludge

At a given pH increment in energy intensity of MW irradiation led to higher biogas yield. Similarly, to the change of BOD, it can be observed, that increase the alkaline dosage to above pH 10 resulted in worsening effect.

CONCLUSIONS

The aim of our research was to investigate the effect of microwave assisted acidic and alkaline pre-treatment on biodegradability of dairy sludge under aerobic and anaerobic condition, respectively. Experiments was carried out in a continuously flow microwave processor unit with different irradiated energy intensity. It can be concluded that acidification and alkalization of dairy sludge are also suitable to achieve enhanced disintegration degree and biodegradability.

Our results show that for enhanced disintegration and anaerobic digestion the alkaline condition can be recommended. Disintegration degree achievable by microwave intensified alkaline treatment was 30% higher than that of it measured for acidified sludge. Applying of microwave-alkaline pre-treatment the biogas yield increased from 152 mL/g to above 300 mL/g in the MW intensity range of 70-230 kJ/L. But it was found, that from the aspects of shorter time aerobic biodegradation the acidic condition applied during microwave irradiation was more favorable.

ACKNOWLEDGEMENTS

The authors are grateful for the financial support provided by the NKFIH under project number K115691. This project was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (MTA), the UNKP-17-4-I-SZTE-5 New National

Excellence Program of the Ministry of Human Capacities and EFOP-3.6.2-16-2017-00010–RING 2017.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

EFFECT OF FREEZE-THAW ON THE TEXTURE OF GLUTEN-FREE PIE CRUST DOUGH

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ABSTRACT
Quick frozen food are becoming increasingly popular among consumers in the last decades. During the development of a quick frozen gluten-free pie crust dough product, the aim was to develop a dough that does not suffer any harmful changes after the freeze-thaw process. The texture is one of the most important sensorial properties, and has a great influence on consumer acceptance. Texture Analyser was used to measure the hardness and the brittleness of various doughs. A quick frozen pie crust dough should be easily cut, but non-crumbling after baking. The results showed that the hardness of a dough with 10% more rice flour was bigger than the other dough's hardness and it became harder after the freeze-thaw process, while the other dough's hardness have not changed during the process. The first dough was less brittle than the second dough, also before and after the freeze-thaw. In conclusion, the 1st dough is harder, so it is not more easy to cut than the 2nd dough. However, the first dough being less brittle allows cutting with less crumbs. Considering the expectations, in the future the first recipe should be used to make a fast-frozen pie crust dough product.

Keywords: gluten-free, pie crust dough, freeze-thaw, hardness, brittleness

INTRODUCTION

Quick frozen food are becoming increasingly popular among consumers in the last decades. The so-called ready to heat products require minimal preparation after purchasing (POTI ET AL., 2015). During developing a quick frozen pie crust dough product, the aim is to reach the highest available nutrient content while the dough does not suffer any harmful changes after the freeze-thaw process.
Flour mixtures made of pseudocereals can be used as nourishing ingredients in gluten-free products because they have excellent protein profiles, contain significant amounts of dietary fiber and minerals such as calcium or iron (ALVAREZ-JUBETE ET AL., 2010).
The use of flour mixtures containing two or more gluten-free cereals is advantageous in eliminating the individually displayed unfavorable sensory and texture properties (HAGER, 2013). Examining various cereals and pseudocereals, revealed that buckwheat contains most polyphenols and has the highest antioxidant capacity (GORINSTEIN ET AL., 2007). Rice has high lysine content compared to other cereals (BIENVENIDO, 1993). Researchers measured high resistance starch, dietary fiber, mineral and antioxidant content in millet (RAGAEE ET AL., 2006). In a study, biscuits with high-millet content had the best flavor, texture and overall acceptance (ENECHE'S, 1999). In an other study, it was found that the flavors that arose after baking and the freshness of the bread improved, and the dough was better preserved when it was enriched with potato flour (WILLARD AND HIX, 1987). Starch in potato improves water binding and stabilizes the texture during freeze-thawing (CRAIG ET AL., 1989).
The texture is one of the most important sensorial properties, and has a great influence on consumer acceptance (BOUACIDA ET AL., 2017). A quick frozen pie crust dough should be

easily cut, but non-crumbling after baking. Our aim was to measure the difference of hardness and brittleness in two different gluten-free pie crust dough before and after the freeze-thaw process. Additionally, to determine the freeze-thaw stability and to decide which one should be used for further development.

MATERIAL AND METHOD

Sample preparation:
Two different gluten-free recipes were used to compare the changes of the texture properties after freeze-thaw. The recipe and the method of making is based on the US5766664A patent (YIGAL AND POPP, 1998). The gluten-free flour mixture included rice-, millet-, and buckwheat flour, and potato flakes were used as starch. The difference between the two recipes was that the 1st recipe contained 10% more rice flour than the 2nd recipe. The pre-baking was at 180 °C for 8 minutes in a Lainox VE051P oven.

Quick-freezing and baking:
Nortech QCF 103 quick freezer froze the unpackaged samples to -30 °C by 3 m/s air speed. The samples were placed in polyethylene sachets then stored for 24 hours in -24 °C. After the storage, the samples were baked at 180 °C for 15 minutes. The measurements started after cooling to room temperature. In total, the whole preparation process included the making of the pie crust dough, the pre-baking, the freezing, the baking and the cooling to room temperature.

Texture analysis:
Hardness and brittleness were measured with a Texture Analyser (TA.XT plus, Stable Micro Systems – SMS) on cuboid pieces (20 mm diameter, 10 mm height and 50 mm lenght). A cutting test was performed with the Blade Set at room temperature, at a constant deformation speed of 2 mm/sec the blade cut through the samples. The cutting test was performed with both samples of dough and each measurement was done twelvefold. The average value for hardness and brittleness was calculated. Hardness was defined as the maximum of the cutting force (F [N]), and the deformation belonging to the maximum force was defined as brittleness (D [mm]) according to the analyser's application study (TA.XTPLUS APPLICATION STUDY, 2000).

RESULTS

Figure 1 shows the instumentally determined hardness of the 2 different pie crust dough before and after freeze-thaw. The 1st recipe dough was harder than the 2nd recipe dough and it also became 4 N harder after the freeze-thaw process. The hardness of the 2nd dough has not changed after the freeze-thaw process. Even though the 1st dough became harder because of the freeze-thaw, this difference is minor compared to the difference between the two kinds of dough. The expectation is an easy-to-cut product, and we concluded that the 2nd dough is less hard that the 1st, so the 2nd recipe would be better for product development according to the results of the hardness measurements.

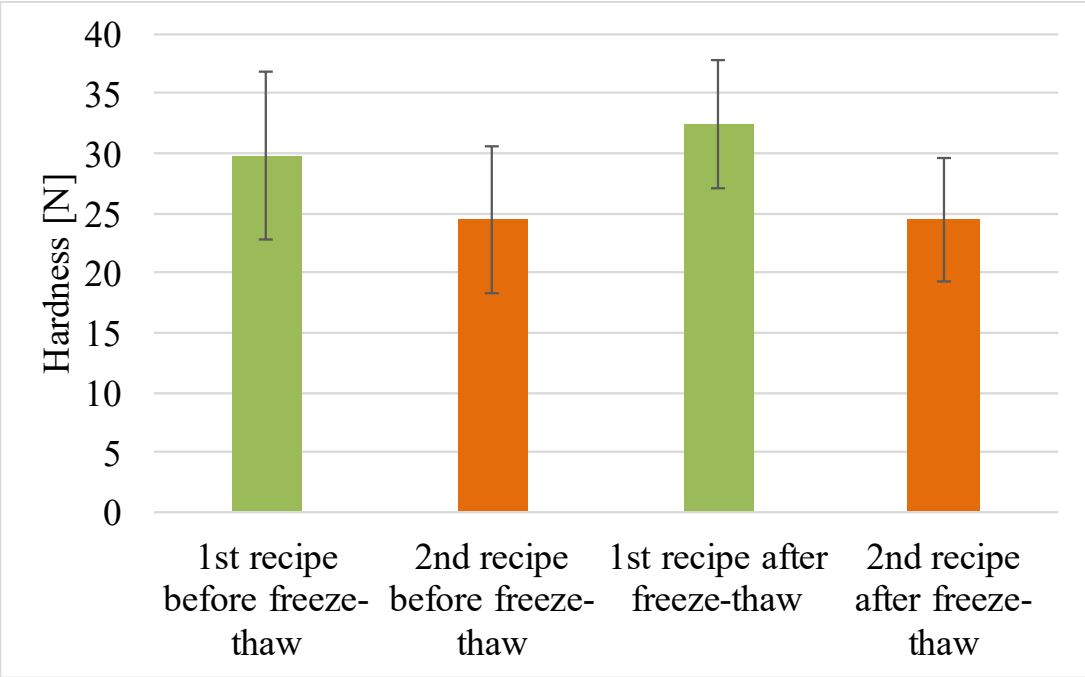

Figure 1. Instrumentally determined hardness of various pie crust doughs

The data of the instrumentally determined brittleness of the 2 different kind of dough can be seen in *Figure 2*. The brittleness was defined as the deformation belonging to the maximum force, and the smaller this value is, the more brittle the product was. The 1st dough became more brittle after the freeze-thaw process, but the 2nd dough became less brittle after freeze-thaw process, although this change was not considerable. The most important is that the 1st dough was nearly twice less brittle before the freeze-thaw, and 20% less brittle after the freeze-thaw.

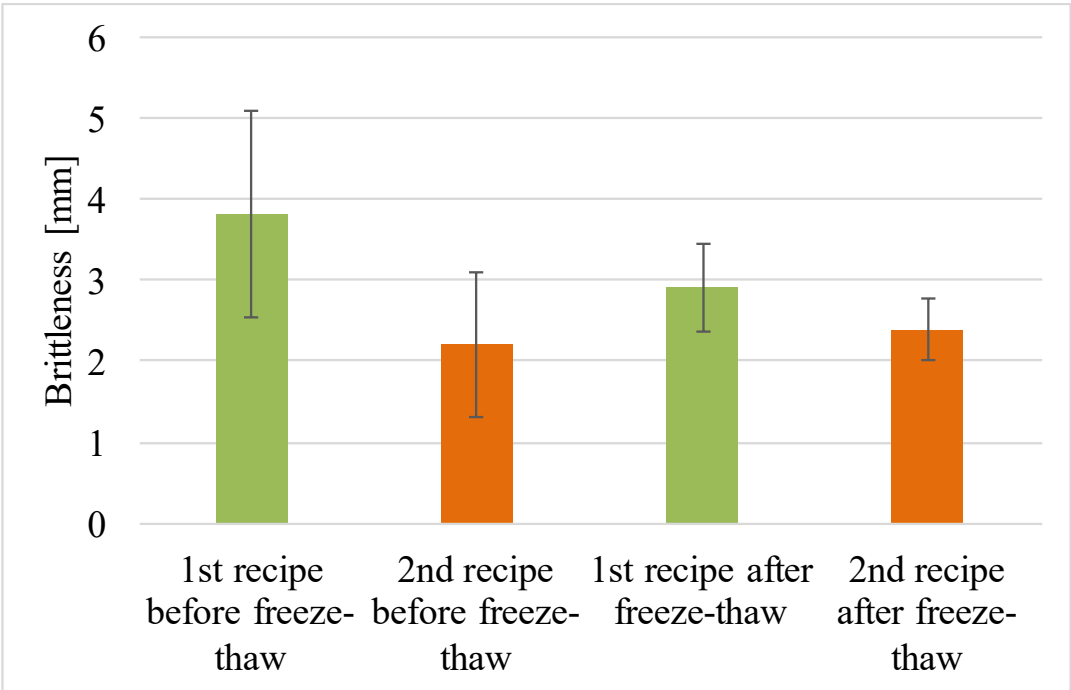

Figure 2. Instrumentally determined brittleness of various pie crust doughs

In conclusion, the 1st dough was harder than the 2nd dough, and the 1st dough was less brittle than the 2nd one. The main expectation in our product development was a non-crumbling gluten-free pie crust dough, and the less brittle dough is considered as less crumbling, thus the 1st recipe was chosen for further analysis. Even though the 1st dough is harder, it is less brittle, so in conclusion, the product will be easily cut with little crumbling.

CONCLUSIONS

In this study, perception of cutting a pie crust dough was measured with a texture analyser to decide between two gluten-free dough recipes. Texture attributes can be correlated to usability of the dough. In the development of ready-to-heat products, like the pie crust dough we have developed, the freeze-thaw stability is an important criterium. After this process, the dough should be easily cut and non-crumbling. Using 10% more rice flour in the gluten-free dough resulted in increased hardness and decreased brittleness compared to the dough with less rice flour.
However, it is unclear how the dough's texture will change after filling it. It is recommended that during the next cycle of product development this subject is further investigated in an other study.

ACKNOWLEDGEMENTS

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

This project was Supported BY the ÚNKP-16-2 New National Excellence Program of the Ministry of Human Capacities

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

UHT TREATMENT OF LIQUID EGG YOLK

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ABSTRACT
Egg and its product are easily perishable items because of their high moisture content, although they have a very high amount of nutrients, especially protein. Many efforts have been channelled to increase the shelf-life of these products but heat treatment according to literature is the most promising although egg and its products are heat-sensitive. Thus, a very low temperature is needed or a high temperature for a very short time. Ultra-Heat Treatment (UHT) is one of the known technologies that we used for heat-sensitive products. The aim of the study was to investigate the effect of UHT treatment (approximately 67 °C for 190 seconds) on Liquid Egg Yolk (LEY) and Liquid Egg Yolk with additive (LEYA). During twenty-one days, the pH and colour were measured every seven days for all the samples. Emulsion stability was also studied by the methods of heat stability for mayonnaise. pH and colour measurements were used assess the quality of liquid egg yolks after 21 days of storage. From the results, raw LEY had the shortest shelf life and gave off a foul smell after 14 days of storage with significant colour changes. Addition of citric acid as an additive however improved the shelf life of the LEY with a relatively low pH. UHT treated LEY also showed improved shelf life of the LEY with a relatively constant pH from day 14 until the end of the experiment (day 21). UHT treatment of LEY with addition of addition of citric acid as an additive may help optimise the shelf life of the product.

Keywords: UHT, egg yolk, additive

INTRODUCTION

Egg products are becoming increasingly popular in food service operation due to convenience of use due to its tendency to save labor, storage, and portion control (Shahbaz et al., 2018). In the egg industry, microbiological safety of liquid products is mainly guaranteed by pasteurization (LECHEVALIER ET AL., 2017). Other methods of pasteurization may be approved when they give equivalent effects to those specified above as the Ultra-Heat treatment (UHT) which require the use of high temperature for a short time (WU, 2014). Intensive heat treatments have been reported to alter the physical and functional properties of eggs by inducing formation or destruction of covalent bonds. This, promotes changes in egg quality as a result of severe thermal protein denaturation (DAWSON AND MARTINEZ-DAWSON, 1998; LLAVE ET AL., 2018). As known, hen's yolk is an important ingredient of a wide variety of food products (BLUME ET AL., 2015). The major applications of egg yolk correspond to the manufacture and stabilization of food emulsions (mayonnaise and salad dressing), foams (bakery products) and gels (custard and caramel custard) (CORDOBÉS ET AL., 2004). Mayonnaise is probably one of the most widely used sauces or condiments in the world today; because of its low pH and high fat content it is relatively resistant to microbial spoilage (DEPREE AND SAVAGE, 2001). Egg yolk is a key ingredient because of its high emulsifying capacity which is related to the phospholipids, lipoproteins (LDL and HDL), and non-associated proteins (livetin and phosvitin) (MOROS ET AL., 2002; ANTON ET AL., 2007; LACA ET AL., 2010; GHAZAEI ET AL., 2015). However, in thermally treated products such as pasteurized egg liquid yolk, gel network formation can

cause unpredictable structure changes through protein denaturation because egg yolk proteins are particularly thermosensitive (BLUME ET AL., 2015).
Many researchers try to reduce the thermal treatment impact on liquid egg product by adding additive.
The aim of the study was to study the effects of UHT treatment on Liquid Egg Yolk (LEY) and Liquid Egg Yolk with additive (LEYA) (approximately 67 °C for 190 seconds).

MATERIAL AND METHOD

All of the samples (liquid egg yolk (LEY)) were supplied from production line of Capriovus Ltd (Szigetcsép, Hungary) directly after treatment with UHT Tubular pasteurizer. Samples were stored at a refrigeration temperature of 5°C in polyethylene bags for 21 days.
The ad of the additive (citric acid) was effected before the treatment.
Colour measurements were done using the Minolta Chroma Meter CR-200, five points of the LEY bag were analysed and the average value was calculated for all samples. Color-difference (ΔE*ab) was calculated using CIELAB system where L* is lightness (black point L*=0, white point: L*=100), a* is characteristic to red-green color (+a* red, -a* green), and b* is the blue yellow color (+b* yellow, -b* blue).

$$\Delta E^*ab = \sqrt{(\Delta a^*)^2 + (\Delta b^*)^2 + (\Delta L^*)^2}$$

To determinate the yolk pH, the bags were emptied into 50 ml beakers before measurement pre-calibrated pH meter (Testo 206). Three replicates per sample were taken for each of the seven days.

The mayonnaise emulsion was prepared according to the formulation described by Huang et al. 2016 but with a substitution of soybean oil for sunflower oil. The mayonnaise was composed from 1.3g sugar, 0.67g salt, 4 ml vinegar, 40ml sunflower oil, and 10g yolk.
50 ml from each mayonnaise sample was poured into a 100 ml beaker and placed in a water bath with varying temperature levels of 20°C, 40°C and 60°C for 1 hour (60 mins). If the emulsion didn't break within this 60 minutes period, no data was recorded for time. The test was done in triplicates.

RESULTS

pH

The evolution of pH for the LEY throughout the conservation period is described on (*Figure 1*). In the beginning of study, the pH values of raw and UHT LEY didn't had no significant difference (7.48-7.7). While the pH value of UHT LEY with citric acid was approximately 5.45; this low value is explained by the addition of the citric acid.
During the 21 days of storage, the yolk pH was decreasing. The raw and UHT LEY pH considerably decreased on the first week, to an approximately 5.7 pH level.
UHT LEYA steadily diminished to 4.95 pH level, until the third week to some extent decrease. Despite the raw and UHT LEY preserve the same pH value to the end of studies.
In the time using coating by beeswax, *Aloe vera* gel and gelatin by (MUDANNAYKA ET AL., 2016) didn't changed considerably the pH values during 3 weeks while the samples was stored at 30 °C without heat treatment. These results may be due because they used the whole egg.

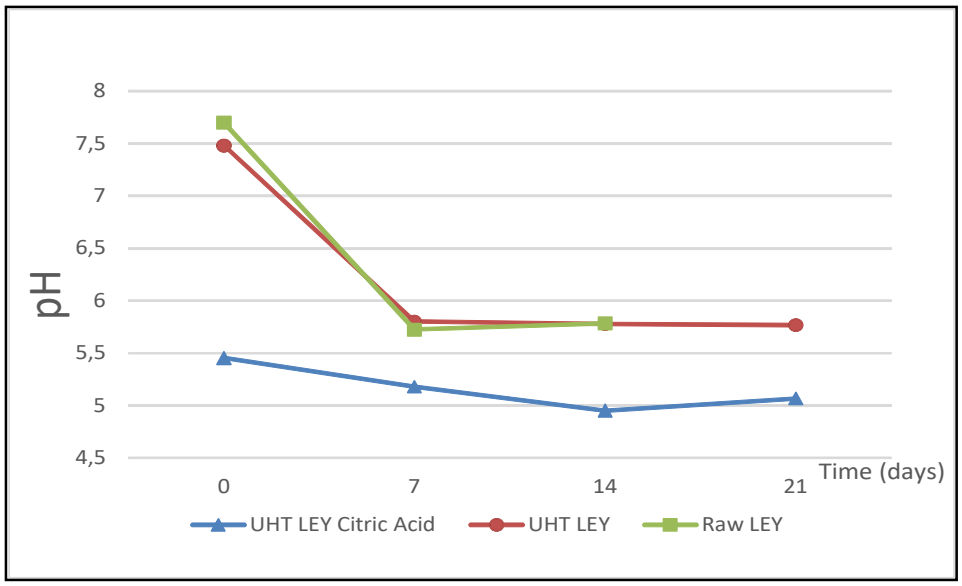

Figure 1. Evolution of pH for UHT LEY with citric acid, UHT LEY and raw LEY

From (*Figure 1*), raw LEY, UHT LEY and LEY with citric acid had a steady decrease in pH from 7.6, 7.5 and 5.5 respectively to a pH 7. UHT LEY with citric acid however, continued to decrease to a pH of 14 before rising again to pH 5 but raw UHT and UHT LEY remained relatively constant at pH 5.8 until the 21 days duration period of the experiment. The lower pH content of UHT with citric acid was attributed to the use of citric acid as an additive. Products with low pH are known to inhibit microbial proliferation. This suggests that UHT LEY with citric acid may be more resistant to microbial contamination compared to raw LEY and UHT LEY. UHT treatment is effective in destroying microbial presence but the ubiquitous nature of microbes exposes it to recontamination. Combining UHT treatment and citric acid as a preservative will therefore provide the best shelf-life options for LEY.

Color

Table 1. ΔE*ab between UHT LEY, UHT LEY with citric and and the raw LEY

	Day 0	Day 7	Day 14	Day 21
Raw LEY - UHT LEY	**7.29**	**4.92**	**7.99**	**8.35**
Raw LEY - UHT LEY with citric acid	**8.55**	**3.35**	**6.70**	**7.98**

ΔE*ab allows us to compare the color between the reference which in this case is the raw LEY and the two samples which are the UHT LEY and UHT LEY with citric acid. The results are showed on (*Table 1).* The major color difference for the UHT LEY with additive was on the beginning of the studies where the ΔE*ab reach 8.55 while the UHT LEY showed the major colour difference on the last day of storage (8.35). This difference can be caused by the denaturation of egg yolk protein. As the DSC results mentioned on (CORDOBÉS ET AL., 2004) the egg yolk protein denaturation start from 60 °C. However, depending on the severity of the treatment and intrinsic factors such composition and pH, major protein can occur (VAN DER PLANCKEN ET AL., 2006). Despite the heat treatment on this study is 67 °C for approximately 3.5 minutes probably some proteins are damaged on the treatment.

Emulsion stability

Despite the high oil content relative to water, mayonnaise is an oil in-water emulsion (DEPREE AND SAVAGE, 2001). And an oil-in-water emulsion system can be broken by the increase of temperature and oil exudation happens as a result (HUANG ET AL., 2016). Until the last day of the measurement, all the mayonnaise samples of 20 °C didn't show any difference.

While from the beginning of the study, raw LEY mayonnaise showed an oil exudation from the first 10 minutes on both temperature 40 °C and 60 °C. Both of UHT LEY and UHT LEY with citric acid mayonnaise keep their texture the whole hour on the two temperatures 40-60 °C.

Starting from the first week, the UHT LEY mayonnaise started to exude oil in the end of 60 minutes at 60 °C (*Figure 2*). The UHT LEY with citric acid mayonnaise start to exude the oil from third weeks at 60°C. Although, both of the mayonnaise starts to exude oil at 40 °C on the third weeks. On day 21, we observe that the oil exuded on the UHT LEY with citric acid is much more than the quantity of oil exuded on UHT LEY (*Figure 3*).

Figure 2. Heat stability of raw, UHT and UHT with citric acid LEY mayonnaise on day 7

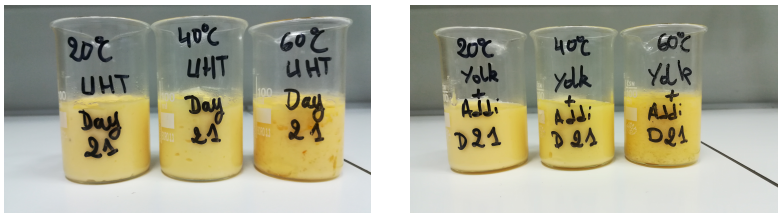

Figure 3. Heat stability results of raw, UHT and UHT with citric acid LEY mayonnaise on day 21

CONCLUSIONS

In this study, we tried to focus on the effect of UHT treatment and the addition of citric acid as an additive on the functional proprieties of liquid egg yolk. The addition of citric acid on LEY improve the heat stability of mayonnaise for the first two weeks of storage. Although, it can affect the colour of the LEY. Overall, the UHT treatment showed that it can preserve the proprieties of LEY.

ACKNOWLEDGEMENTS

We want to thank Capriovus Ltd (Szigetcsép, Hungary) for their help and for providing us with the samples we need.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

UNDERLYING CAUSES OF GLOBAL FOOD PRICE CHANGES

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ABSTRACT
There is a significant increase in food prices all over the world. Rate of annual increases in prices of all kinds of food is more than 100 percent. However, this can lead to long-term food crisis. The research aims to find out the factors that contribute to a large increase in food prices, as well as to predict the likely consequences of food price increases. Then potential solutions related to specific problems should be highlighted. In this study several factors were determined, which were contributed to central (global food price increase) and general problems. These problems were separated by cause and consequences, they were structured and ordered hierarchically. Through outline the problems it can be improved that in global market of foods both demand and supply are influenced by many factors. The most important factors affected demand are: increase of population and urban population all over the world and increase of income level and internal migration in emerging countries. Supply is influenced by the following factors: a decrease in the yield of agricultural crops, low level of productivity in agricultural sector, as well as reduction in food crops production area because of unfavourable weather and increased production of biofuels. Most of general and specific factors, which affect food price increase, are related to each other causally but there are also separate factors. The most effective solution to the problem is increasing of agricultural productivity at the same time investments into agricultural researches and rural infrastructure.

Keywords: food price increase, demand, supply, causes, consequences

INTRODUCTION

Foods are essential consumption goods, so demand for foods is permanent and it is increasing in line with population of the world. At the same time agricultural land is limited on the earth, so food production can not be increased indefinitely. Moreover, area of arable land is decreasing continuously. Partly, this is a result of climate change, which has caused desertification in some parts of the world. The other problem is the widespread biofuel production today. For this required oil crops are grown in areas, where food crops were grown previously. All in all, an unfavourable trend emerged recently, whereupon supply and demand changes in the opposite direction in food market (demand increases and supply decreases permanently), after all, consumer prices increased significantly.
According to FAO report global food prices have increased since June 2010 permanently and the global food price indices are higher than 200 percent since 2011 (FAO, 2017). The real food price indices are below the nominal rates somewhat, however, there was observed a significant increase in those changes. This food price increase trend seems to be sustained both in nominal and in real terms. However, the food price index measured by FAO is an average rate, which value is increased by sugar and dairy commodity primarily (sometimes even more than 250 percent), this rate approached 200 percent on market of meat, grain and vegetable oil products several times.
There was a global food crisis in 2008, but researchers did not assume to be repeated in such a short period of time, and that the latter one would be so permanent. Food price increase of the year 2008 occurred after a declined trend of prices, which lasted for about three decades. Analysts and experts debated about factors that primarily contributed to global food price increase in 2008.

Global food price increase in 2008 hit the net food importer developing countries, while net exporters realized benefit. The price increases enhanced poverty, malnutrition, and vulnerability to external shocks in poorest regions of the world. However, some analysts thought that rising prices will offer new revenue-generating opportunities for farmers in developing countries, whereby farming can contribute to economic growth increasingly. However, this was not realized due to current prise rising (BRAUN ET AL., 2008; ROSEGRANT, 2008).

The current long-term global price increase is different from the crisis of the year 2008 in several ways. In point of food price increase different views were emerged among experts and analysts in 2008. According to some experts, current price increase was not caused by supply decrease, but it was caused by a strong demand growth beginning in the Far East and by weather conditions (drought in Eastern Europe, extreme weather in Central Europe, etc.) However, according to other experts, prices are forced up by speculation on commodity market. The most disputed topic is the food-shortage caused by production of biofuels and its upward pressure on prices of food raw materials (VILÁGGAZDASÁG, 2011).

Current prices are clearly favor for major exporter countries such as Australia, New-Zealand, United States, Canada. Food price soaring hit the poorest countries. The price increase is expected to hit about 70 African and Asian countries (EUROPEAN COMMISSION, 2011).

Basic hypothesis of this research is that the food price increase began in June 2010 was caused by increase in demand of foods and decrease in supply of raw materials. Both processes were induced by simultaneous presence of several factors. Increase of demand is mainly due to the population growth, the income level increase in emerging countries and internal migration. Decrease of supply is caused by factors such as less arable land on agricultural production because of climate change, more and more widely spread in production of biofuels, as well as decline in agricultural crop yield due to unfavourable weather conditions in recent years. Of course, many other processes also contributed to global food price increase, which are related to each other causality.

Basic objective of this research is to reveal the factors that contributed to the global and long-term food price increase, which is permanent since 2010. These factors were categorized, and targets or rather propose solutions were assigned to problems. Execution of this a problem and objective tree analysis was carried out.

MATERIAL AND METHOD

In this research a problem and objective analysis was used. It shows negative aspects of an existing situation. There should be a negative situation, because the "why?" question applies to it. This should be formulated possible the most general. This will be the starting point that is the central problem. This level is above the concrete situation, often a combination of social, economic and environmental problems. To this belong causes and effects. The specific problems are located below the central problem, and central problem is resulted by these. There is a causal relationship between these problems. At the bottom of the hierarchy starting problems are found, many of these are jointly contribute to the appearance of a high-level problem. During the outline outline problems have to be translated into goals, that is to say, each problem is converted to targets. On three levels structured targets (general, specific, operative) make up the marrow of logical framework of the strategy. There are specific objectives on lower levels, overall goals on middle levels, and strategic goal is found on the top of objective tree. The cause and effect

relationship is followed by means and targets relationship. Targets related to similar areas are grouped and listed under common name.
In this study different problems were assumed in that were determined several factors, which were contributed to central (global food price increase) and general problems. These problems were separated under cause and consequences and were structured and ordered hierarchical. Thereby possible direct and indirect causes of the food price increases and some of those consequences were outlined.

RESULTS

General causing factors of fast increase of food prices are the massive increase for foods in the world, the agricultural products and the reduction of decreases of food supply, the increases of food costs, and the spread of stock market speculation commerce of agricultural products.
Need of foods, and increasing demand is inducated by three main processes. One of causes of increases of demand in recent years is the dynamic growing of whole population. The world's population growth rate declined from the 1970's, but world's population still grows 75 million (1.1 percent) persons per year, mainly in developing countries. The other two processes are interrelated. On the one hand there was an intensive income level rise in developing emerging income level decrease, that lasts in present. On the other hand, primarily in these countries, but also in other developed regions a massive process of urbanization was begun. The urban residents in the world are growing. The traditional agricultural sector, the agricultural production is left by more and more, the people were moved to cities, and they signed on in industrial sector. Direct and indirect causes of migration between downtown and sectors are varied, but the main direct cause of migration is the huge differences between urban and rural incomes. Large geographical distance is offset by the higher income. In addition, migration may also be contributed by targets, such as increasing the level of education, to avoid rural social and cultural "captivity", and following family members. Migration between urban and rural areas in developing countries is growing at an increasing rate even though the urban labor surplus and the unemployment rate are rising. Migration from rural areas is a prerequisite for urbanization as well as economic growth, and it provides resources for development of rural areas in developing countries, but it also has got numerous negative effects. It is possible that a huge flow mass can not be absorbed in the cities, so that the migrants do not reach an adequate level of public goods. As a consequence, there will be an increase in crime and develop the slums. Urbanization causes imbalances inequality between population distribution of, as well as inequality between urban rural areas (LALL ET AL., 2006).
The other hand the level of education of developing countries was improved. More and more got a better qualification and got a work in the sector that needs a higher qualification.
Internal migration between sectors, and thereby the urbanization cause problems, because more and more significant manpower leave agriculture. The number of people is reduced, who are producing primary commodity of food for themselves and the society in industry. Thus, agricultural production is reduced too. Meanwhile the number of people is growing who needs food. The internal migration is also linked to income level rise, because by migration of agricultural sector an extreme industrialization process is started, the industrial production is growing. A higher income level can be reached, than by the agricultural production. Because of the recent increase in income level consumption habits of society have changed in some developing countries. Rice and wheat may come to the

forefront instead of sorghum and millet. Consumption of corn, wheat, meat and dairy products have increased significantly in these countries. More animal products, fruits, vegetables and processed foods are consumed.

Global increasing demand of foods is although influenced by population growth, that doesn't mean problem itself. It comes with the fact, that in the emerging countries the income level is rising. Growth of global demand for foods exceeds growth of population. That means, that the population in developed and emerging countries needs a higher quantity of foods, than earlier. So, foods are bought much higher quantity than necessary for subsistence food. These foods are squandered, when it isn't eaten. On the other hand – due to the increasing scarcity of food goods – in many countries around the world people are starving, because they don't get enough quantity of food.

Other problem is decrease of food supply that strengthens the price raising effect of increasing demand. Decrease of supply is attributable of five main causes, the link between these is less close, than between the elements of demand. Although between these triggering facts there are overlaps. The first triggering fact is the reduced crop yield of agricultural products. One of causes is the more extreme weather in last years (droughts, rainy summers, etc.), because as a result of this crop yield is reduced significantly.

Other cause that can be also linked to extreme weather is that the soil water started to lessen. That comes with the drying up of soil, and eventually with growing of irrigations costs. There's a fact, that leads to reducing of yield crop, and that's also the general problem of global food supply: low level of sources are invested in the agricultural research and development, and in using modern technology. The infrastructure on countryside is underfunded too.

If there won't be an investment in research and developing, there can't be ennobled plant species with high yield crop. In default of new technologies and developed infrastructure effectiveness of production reduces largely. Another problem is the above-mentioned internal migration between sectors in developing countries. Therefore, number of manpower in agriculture reduces largely. The fourth difficulty is the low level of food reserves.

Last but not least it should be mentioned the decreasing area of food production agriculture- perhaps the most disputed theme in the world. In last years – the much discussed – climate change caused environment changes on number parts of world (desertification etc.), that doesn't fit to living conditions of plants there. An another cause of reduced agricultural area of food production is, that in recent times biofuel producing is emerged in developed and emerging countries, so on growing areas plants are grown for bioethanol and biodiesel production (oil-plants, maize, sugar cane, etc.). A triggering cause of biofuel productions popularity is, that in recent times the price of petroleum was risen significantly, so it can be a governmental purpose to replace these with biofuels.

Food prices of the world are rising due to changes contrary of demand and supply, and rising of producing costs (material-, energy-, delivering costs). Observing the material costs, it can be determined, that agricultural area - consistenced with mentioned above - is decreasing. Seed and feed plants are also decreased all over the world, so overall by plant growing and animal breeding factory costs of seed and feed is increasing significantly. In recent times fertilizer and pesticide costs are increasing too. Between costs of energy the costs mechanical works are growing which casuses are the above-mentioned rising costs of petroleum. This contributes to high costs of transport.

Another piece of problem are various speculations of stock on the market of agricultural products. By wrong governmental policies in different countries the prices of foods were more exacerbated. Export prohibitions and import limitations are introduced by some

countries, by those the foods in world trade were fallen back, so their supply was decreased more.

In the above-mentioned problem tree, the structured negatives were converted to solution suggestions. Prepared objective tree can be seen on *Figure 4*.

By compilation of problem tree some causes and also consequences are emerged, those were causing factors of central problem, so they can't be ignored, but can't be turned into goals. By these factors, conversation can be limited, because facts can't be influenced by people (eg.: climate change, extreme weather, decreasing of petroleum supplies), or they are hardly influenced (eg.: speculation of stock),

Increasing of food demand can't be turned back totally, because two of its inducing facts (population growth, rising income level of emerging countries) can't be stopped, thus final goal must be the minimalization of increasing of demand. This could be realized, if in each country migration of sectors could be minimalized. So, the population growth of cities would be slowed down. If wages would be raised in agriculture, and people would be encouraged to stay in countryside, manpower wouldn't migrate from agricultural sector to industrial sector.

So, supply of food is concerned too, because manpower in agriculture can produce more primary commodity of foods, than it would be flown to industry. Higher productivity can be reached by increasing the sources in agricultural researching and developing, more developed technologies and in rural infrastructure. Furthermore, even yield crop can be increased with ennobled plants of higher yields. This could be reached possibly by central (national or even regional) support of costs of irrigation. However, the loss of yield crop by extreme weather can't be replaced.

Various speculation decisions can be influenced hardly too, but with right governmental policy enough quantity of food reserves can be made. Growing area of food plants will be reduced in future, so primary goal is to minimalize this reduction.

Not all factors – that affects supply - can be influenced (extreme weather, reducing of soil water, speculation), but all of general problems can be changed less or more. Thus, instead of decreasing supply of food it can be a goal a slight increase of supply. It's optimal, if the rate of increasing supply and demand is the same.

Next goal is to reduce the costs of agricultural production to reach a stagnation or slight increase of global food prices. However as increasing of petroleum prices, energy prices and transfer costs is inevitable, and the cost of various industrial materials (fertilizers, pesticides, etc.) can be influenced limited, so primarily by reducing the costs of seed and feed should be realized.

Instead of a general problem, wrong policy as respond to increased prices it can be a solution, if these policies would fit to principles of efforts of increasing food price problem. Export inhibition and import supports should be withdrawn. There wasn't a massive effect of weaken USD, but the goal is to maintain the stability of Dollar.

If the suggested solutions could be realized, global food prices would increase less, than in last months.

CONCLUSIONS

Through outline a problem analysis can be improved that both demand and supply are influenced by many factors in global market of foods. The most important factors affected demand are: increase of population and urban population all over the world and increase of income level and internal migration in emerging countries. Supply is influenced by following factors: a decrease in yield of agricultural crops, low level of productivity in

agricultural sector, as well as reduction in food crops production area because of unfavourable weather and increased production of biofuels.
As well as, of course, many other factors contributed to food price increase, which do not affect demand and supply directly. These factors are such as an increase in cost of production of agricultural products, typical futures market speculation in agricultural products, weakening of US dollar against other currencies. Most of general and specific factors, which affect food price increase, are related to each other causality, but there are separate factors too.
After all global food price increase took a considerable change because deliberate and chance occurrences took place together and at the same time in the world, and negative particular effects were strengthened, which had various effects on food price changes.
Solution of the problem of food price increase should be sought in main causing factors such increase in demand and decrease in supply. On the demand side, population grow is an irreversible process, furthermore, industrialization and rising level of education are favourable and desirable processes, so these should not be changed. Migration and its main direct causing factor, the low agricultural wages may be changed. The excessive urbanization and migration from agricultural sector to industrial sector should be prevented. People should be kept in rural areas. Its solution is that, adequate mouth existence and living conditions should be given to agriculture workers. In addition, they should receive a fair income. Agricultural and industrial wages should be equalized. Agricultural supports should be given also in developing countries. On the other side, price increase would stop or turn back when increasing needs of the world's population would be satisfied that is to say when the current relative low level of supply would be increased. This solution lies in production technology. Size of cultivated arable land can not be increased (thus land as a special means of production is limited), therefore, the only solution is to increase agricultural productivity.
Overall, to increase productivity, a huge amount of capital should be involved into agricultural researches and into development of rural infrastructure. This is currently only implemented in some countries in the form of foreign investment. In the future, it should be laid stress on this, in that should assume a role governments, the private sector, as well as the resource-poor but capital rich countries and several international financial institutions.

ACKNOWLEDGEMENTS

This contribution is the result of the project EFOP-3.6.1-16-2016-00017 „Initiatives to establish a new source of researchers and graduates, and development of knowledge and technological transfer”.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

ECONOMICAL ASSESSMENT OF AN INVESTMENT RELATED TO THE ESTABLISHMENT OF A NEW FARROWING PLACE AND PIG-REARING BUILDING

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ABSTRACT
In our research work we aimed at carrying out an economical assessment of an investment and development of substantial volume. The examined project was completed at a pig-farm during which a new farrowing place and pig rearing building were built, as well as the renovation of the existing pig-farm. All of them were financed partly from the firm's own source, partly from a non-repayable aid granted by the state, and finally from a credit granted by a commercial bank. The term of the credit is 10 years and the return of the investment expected by the investors is 8%, so we carried out our calculations according to these data. We examined the three possible ways of financing the investment from the economical point of view, as a result we proposed three hypotheses. Our hypotheses are: Hypothesis 1 (Case „A"): The investment will be financially recovered within the examined period of 10 years if it is financed from the firm's own source, the state grant and the bank credit. Hypothesis 2 (Case „B"): The investment can be economically completed within the given period of time if the project meets the costs from the firm's own source and the credit. Hypothesis 3 (Case „C"): The investment will be economically accomplished within the examined 10 years provided the firm finances the project from their own source and the state grant. In our calculations we used the net present value (NPV), the internal rate of return (IRR), the payback time (PB), the discounted payback time (DPB) and the profitability index (PI) as economy indicators. We carried out our calculations regarding 10 years to be able to compare the results since the term of the granted credit is 10 years, too.

Keywords: payback time, discounted payback time, net present value, internal rate of return, profitability index

INTRODUCTION

Pig-breeding is a significant branch of animal husbandry all over the world as it has had an important part in supplying people with food for thousands of years (HORVÁTH AND KOMAREK, 2016). In 2013 the global pig production exceeded the 114 million tons, while the global pig population the 1 billion entities. Presumably, the world's pork production will have approximated the 130 million tons by 2023. The global pork consumption is estimated to increase to the approximate amount of 470 million tons by 2050 (NOVOTNINÉ DANKÓ, 2015). The pork branch has undergone serious changes in the latest periods (BALOGH ET AL., 2013). The market conditions (KÖTELES ET AL., 2017), the consumer habits and needs have altered, also optimization of production costs and efficiency has become a crucial factor (FEHÉR AND SZAKÁLY, 2017). The strict European and regional directives set limits in the fields of health care, ammonia emission, manure management and animal welfare, which make the pig-breeders' situation even more difficult (BRABANT ET AL., 2012). However, the great reproduction capacity of pigs, the good adaptability of theirs and their efficient pork production capacity are all employed in several parts of the world (POPP ET AL., 2013). It is typical to the pig-breeding branch that the investments return relatively fast, they mean a continuous source of income for the firms (BABINSZKY ET AL., 2000).

The gross amount of money needed for the examined investment was 603,000,000 HUF (1,932,011.15 EUR), of which the firm financed 190,000,000 HUF (608,759.732 EUR) from their own resources. The joint stock company gained from a tender 240.000.000 HUF (768,959.662 EUR) in form of a non-repayable aid granted by the state which helped the successful realization of the project. Besides, the company took a loan of 170,000,000 Ft (544,679.76 EUR) from a commercial bank. The examined project was completed at a pig-farm during which a new farrowing place and pig rearing building were built, as well as the renovation of the existing pig-farm was accomplished. The contractors put a great emphasis on realization of the necessary new technology, so they built new roads on the site and a straw-fed boiler was constructed to increase the efficiency of heating in the pig farm, the farrowing place and the pig rearing building. Besides that, a modern ventilation, cooling, fodder transporting, distributing and watering system and a drug delivery panel were installed. The buildings were supplied with slatted floors which made the construction of an efficient fertilizer drainage system, the so-called lagoon-typed drainage system, possible. We should not ignore food safety (FABULYA ET AL., 2015), the logistics of food safety and quality (GÁL, 2008) and the product, the result of production management (IRIMIE ET AL., 2014).

MATERIAL AND METHOD

We consider investment the group of activities which begin at procuring the devices and finish with the installation, so using the devices in the proper way. While by renovation we mean any activity aimed at restoring the original state of any worn out tangible asset which increases the duration time of the given asset, improves its capacity or restores its original mechanical state (MAKNICS ET AL., 2013). It is a characteristic of investment decisions that they bring about a change in either the financial background of an enterprise, or in the sources or in both. We consider an investment good if it has a positive net present value and the firm can realize an economical profit from the completion of the project (FENYVES, 2014). The indicator net present value is the difference between the net values of cash inflows and outflows. It takes both all of the cashflows expected in the future and their risk into consideration. If the net present value is more than zero, the investment counterbalances the expected payback requirement better than necessary, so the project has to be accepted. If the net present value is less than zero, the project has to be rejected, since the investment does not reach the required payback. If the net present value is zero, the payback is the same as the cost of capital, it does not generate changes in the shareholders' wealth, so it is indifferent whether to accept or refuse it (BÉLYÁCZ, 2007). The internal interest rate is a discount rate which makes the present values of all cashflows expected in the future equal to zero, meaning that the net present value is zero. In case of projects independent from each other, if the internal interest rate is more than the cost of capital, the project has to be accepted since it augments the shareholders' wealth. If the value of the internal interest rate is less than the cost of capital, the investment has to be rejected, it reduces the shareholders' wealth. However, if the indicator value is equal to the cost of capital, the decisionmaker may be indifferent regarding the acceptance or the rejection of the project, as the investment is not expected to change the shareholders' wealth. In case of projects mutually excluding each other on the basis of the internal interest rate we can have a different result than by means of the net present value, the reason of which is the re-investment propisition (FENYVES ET AL., 2014). The discounted payback time integrates the advantages of both payback time and dynamic indicators. It indicates the measure of risks and liquidity. The indicator expresses how many years are necessary for the investment

that the initially invested capital can show a return. When calculating it, we try to find that point in time when the amount of accumulated cashflows reaches the value of the initial capital investment (YESCOMBE, 2008). The profitability index shows the amount of the expected profit after the invested sources. If its value is more than one, the investment augments the shareholders' wealth, so the project can be accepted. If its value is less than one, the project has to be rejected, since less than a unit of the present value of the investment payback comes to a unit of investment (ILLÉS, 2009).

RESULTS

We employed the above mentioned economical indicators in proving all of our three presumptions, on the basis of which we were capable to decide whether the investment shows a return or not in the given way. Before starting the calculations, by means of the firm revenues and expenditures, and other budget data we defined the cashflows generated during the examined period of time and then we could start the economical calculations. We are presenting our results in the following table (*Table 1*).

Table 1. The results of our calculations

Name	Case „A"	Case „B"	Case „C"
Net present value (NPV)	NPV=71,200,000 HUF (228,124.7 EUR)	NPV= -4,700,000 HUF (-15,058.8 EUR)	NPV=150,300,000 HUF (481,560.9 EUR)
Internal rate of return (IRR)	IRR=11.2%	IRR=10.4%	IRR=13.5%
Payback time (PB)	PB= 5 yrs	PB= 6 yrs	PB= 5 yrs
Discounted payback time (DPB)	DPB= 9-10 yrs	DPB= 10-11 yrs	DPB= 8-9 yrs
Profitability index (PI)	PI= 1.1 HUF	PI= 0.9 HUF	PI= 1.2 HUF

Source: our own data

In ***Case „A"*** (Hypothesis 1) we presumed that the investment will be financially recovered within the examined period of 10 years if it is financed from the firm's own source, the state grant and the bank credit. The net present value resulted 71,200,000 HUF (228,124.7 EUR), so it was more than zero, on the basis of which the investment is expected to increase the value of the enterprise and to result in a positive net income during the examined period. The value of the internal interest rate is 11.2% which is more than the profit of 8% expected by the investors, so the project can be accepted. The payback time is 5 years, so that time is necessary so that the investment can be recovered from the results given by the investment. Since it is less than the expected 10 years, this indicator also proves that the project can economically return. Calculating the discounted payback time, we got as a result that the present values of the future revenues reach the values of the present expenditures in 9-10 years, meaning that the investment returns in 9-10 years. According to the result of the profitability index, during the project more than 1 HUF, (1.1 HUF), of return can be expected after each 1 HUF of investment. So the investment is profitable in this case, too. The economical indicators calculated in Case „A" show positive results, so our Hypothesis 1 is reinforced, meaning that the investment can be recovered within 10 years if it is financed from the firm's own resource, state grant and credit.

In ***Case „B"*** (Hypothesis 2) we assessed the investment without the state grant and its return. In this case, the results differed from what we had presumed. The net present value

showed a negative value: - 4,700,000 HUF (- 15,058.8 EUR), so it can be concluded that the investment does not bring about a positive net income, it reduces the value of the enterprise within the examined period. In spite of the unfavorable result, we calculated the other indicators, too, in order to see if they have the same result. The internal interest rate showed a positive value of 10.4%, which is more than what the investors expected (8%). On the basis of the payback time, 6 years are necessary to turn the investment to make profit. It is less than the expected 10 years, so the project can be accepted. The results of the internal interest rate and the payback time conflict with the one of the net present value, since it shows that the investment will not bring about profit in the examined 10 years. One of the reasons is that the payback time does not take the time value of money into consideration, also does not measure the profitability of the project proposal, moreover, the internal interest rate often leads to a result contrary to the net present value. All in all, we can conclude that in case of investment decisions it is worth acting considering the results of more indicators. The discounted payback time, in this case, was out of the period of 10 years. The investment will return within 10-11 years, on the basis of the calculation. The result of the profitability index shows that in case of 1 HUF of invested capital we can get back 0.9 HUF, so less than 1 HUF, meaning that the project reduces the enteprise's value. To sum it up, our Hypothesis 2 cannot be confirmed, since, on the basis of the results of 3 indicators out of 5, the investment is not economical and profitable, either, in the examined period of 10 years, thus we rejected this hypothesis.

In ***Case „C"*** (Hypothesis 3) we intended to prove that the investment can be recovered from the firm's own source and state grant, without bank credit, will be recovered within the period of time of 10 years. The net present value was 150,300,000 HUF (481,560.9 EUR), so it was more than zero, which proves that the investment increases the firm's value within the examined 10 years resulting a positive net income. The value of the internal interest rate was 13.5% which is more than the 8% expected by the investors, so the investment can be accepted. On the basis of the payback time, the project turned to be profitable after 5 years, so this indicator also proves that the investment is acceptable. On the basis of the discounted payback time, the present value of the future revenues reaches the value of the present expenditures, the 603,000,000 HUF, within 8-9 years. According to the profitability index, the investment brings about profit, since we can get back 1.2 HUF after each invested 1 HUF. All in all, the total results prove our Hypothesis 3, so the investment will be recovered in 10 years from the firm's own resource and state grant, without bank credit.

CONCLUSIONS

As a result, it can be concluded that two of our three hypotheses were reinforced, while one had to be rejected.

On the basis of our results, the investment will be economically recovered in 10 years being financed from the firm's own resource, state grant and credit (Case „A", Hypothesis 1). This statement is supported by the positive net present value, the favorable internal interest rate, according to which the investment profit is better than it was expected by the investors. Also, the results of the payback time and the discounted payback time and the profitability index show that the investment is profitable in the examined period of 10 years.

The completion of the project can be successful without a bank credit, too, only from own resources and state grant (Case „C", Hypothesis 3) and will be economically recovered. On the basis of the results the financing method of the Case „C" is the most welcoming for the

firm, since the net present value is the highest in this case which increases the value of the enterprise, the value of the internal interest rate is the most positive, so the investment can bring about the largest profit here. Also, on the basis of the profitability index, it is the Case „C" which makes the most profit. Besides, the values of the payback time and the discounted payback time are the lowest in this case, so the fastest payback can be expected in Case „C".

However, the investment will not economically recovered within the examined period of 10 years if it is financed only from the firm's own resources and bank credit, which was assessed in Case „B", Hypothesis 2. It is proved by the negative net present value, the unfavorable profitability index, according to which the investment is in the red in the examined period of 10 years. In addition, the value of the discounted payback time reflects, too, that the investment will not be returned in 10 years.

ACKNOWLEDGEMENTS

This research has been supported by the Ministry of Human Capacities, Human Capacities Grant Management Office and the National Talent Program (Proj. No NTP–HHTDK–017–0004).

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

EXAMINATION OF FISH CONSUMPTION HABITS AMONG STUDENTS OF A SECONDARY SCHOOL IN SZEGED AND OF A UNIVERSITY FACULTY

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ABSTRACT
Due to our environment or to our own decision, we try to pay attention to healthy nutrition (SZAKÁLY ET AL, 2014). We pay attention to the composition of the products and try to exclude certain foods (KONTOR ET AL, 2016). Experts state that fish consumption is one of the indispensable conditions of a healthy diet, so we should consume fish at least once per week (SZAKÁLY, 2011). *Figure 1* shows as well that despite the fact that fish is delicious and healthy, it is not part of our everyday diet (KISS, 2017).

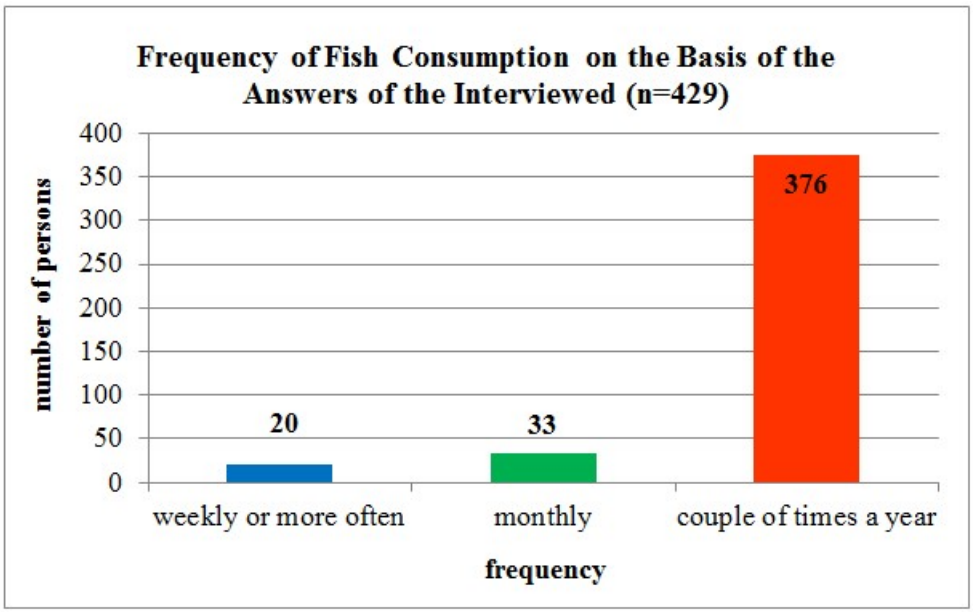

Figure 1. Chart on the frequency of fish consumption
Source: own-made chart on the basis of the evaluated questionnaires

The focus of my research was to survey the habits of fish consumption among the students of a secondary school and of a university faculty in Szeged. My goal was to uncover the causes behind the low rate of fish consumption. Furthermore, I aimed to investigate that, beside fish, which types of meats are the most commonly consumed among the interviewed. A study of last year shows the connections between nutrition attitudes and meat consumption, from which it turns out that several factors influence our meals (NÁBRÁDI ET AL, 2017). During my research it was revealed that the price of fish plays a decisive role in consumption.

Keywords: fish, consumption, Z-test, seasonality

INTRODUCTION

Earlier ZSÓTÉR AND KALICZKA (2014) also dealt with the examination of consumer habits. Numerous professional works have been published on the observations of the effects of food-producing companies (ZSÓTÉR AND CSÁSZÁR, 2013) and on food-industrial

investments (ZSÓTÉR AND TÚRI, 2017). It justifies my topic choice that I consider the endeavours for a healthy life extremely important. Many food consumption risks are known, but the alternatives to handle them are also available (LEHOTA, 2006).
The major part of nutrient sources, vitamins (e.g.: A; B_1; B_2; D), minerals and various unsaturated and polyunsaturated fatty acids (e.g.: Omega-3 fatty acid) essential to our organism can be ensured by consuming more fish (SZAKÁLY, 2017). Fish consumption is a pivotal part of healthy way of life (KISS ET AL, 2016).

The comprehensive goal of my research was to introduce the physiological role of fish consumption and the fish consumption habits among the students in a secondary grammar school and a university faculty. On the basis of the research conducted by me I aim to investigate the following hypotheses:

1. The number of those interviewed is higher who do not consume fish than the number of those who, even if only rarely, consume different types of fish or fish meats.
2. Beside fish, fish consumers most commonly consume poultry and pork.
3. Regarding fish consumption, high seasonality can be observed—for example during Christmas period the interviewed consume more fish.

MATERIAL AND METHOD

The basis of my primary research was a questionnaire complied by me, which was filled in by Miklós Radnóti Secondary Grammar School students and by the students of University of Szeged Juhász Gyula Faculty of Education. Altogether 429 questionnaires were filled in. The interviewer was me—fostering with this the proper fill. I visited the above mentioned institutes on four different days in 2017 March and April. In the secondary grammar school my former teachers ensured possibility to fill in the questionnaire in lessons and head teacher's lessons, with which students helped my work. In the university faculty, thank to a helpful lecturer, the students could fill in the questionnaire in a lecture. My questionnaire consisted of 15 questions, of which 10 questions related to the fish consumption habits and relevant opinion of the interviewed, and 5 questions revealed demographic data. Most of the questions were closed ones. After compiling the questionnaire I have conducted a test fill-in in the end of February, 2017. With this it could turn out if the logical built-up of the questionnaire is appropriate and the types of questions are ideal (LEHOTA, 2001). The number of interviewed was 435 altogether, but 6 of the questionnaires could not be evaluated, so during the evaluation I was examining a sample of 429. I have informed the persons involved in the research both about the aim of this current work and about the fact that I have handled the given data with full respect for personal rights (MALHOTRA, 2008). I have evaluated the questionnaires with the PSPP statistical system, which substitutes the patented Statistical Package for the Social Sciences, SPSS program (SAJTOS AND MITEV 2007). I have chosen this possibility so that I could process the data effectively and fast (HUZSVAI AND VINCZE, 2012). PSPP is excellent to compare results from analyses (JÁNOSA, 2007). I have conducted hypothesis investigation using Z-test, where we claim a thing and check on the basis of a pattern appearing during the investigation if it is also true for the whole lot with given (95%) probability.

RESULTS AND DISCUSSION

In the introduction of this work I formed three hypotheses where the answer to their evaluation has come from the data of my later, personal research and their assessment. In

view of the scope limits, I do not publish the details of the research results in this study, this part of this paper focuses on sharing the final results of hypothesis examination.

1. **Hypothesis:** The number of those interviewed is higher who do not consume fish than the number of those who, even if only rarely, consume different types of fish or fish meats. With other words: in the examined lot the ratio of fish-consumers is more than (or at least) 50%.

n=429 (size of the sample) Do not consume fish: 30 prsns
k=30 (number of interviewed according to null hypothesis) Fish Consumers: 399 prsns
P=0.5000 (the expected value) Summa interviewed: 429 prsns
p=k/n=0.0699 (value counted from sample)
Z-test: H_0: $p \geq 0.5$ ← Null hypothesis.
H_A: $p < 0.5$ ← Alternative hypothesis, on the basis of relation sign left-side test.
↓
(At a left-side test we accept null hypothesis if z-value > critical value.)
Level of Significance: α=0.05 (error probability)
Range of acceptance (critical value): $Z_{0.05}$= ─1.645

Z-Test Value: $Z = \frac{k-nP}{\sqrt{nP(1-P)}}$ or $Z = \frac{p-P}{\sqrt{\frac{P(1-P)}{n}}}$ **-17.815**

Statistical Conclusion: Z-test value is smaller than critical value → we reject null hypothesis at a 5% significance level, and in the case of 95% probability.
Professional Conclusion: in the examined sample there are more fish consumers than non-consumers.

2. **Hypothesis:** Beside fish, fish consumers most commonly consume poultry and pork. With other words: among those who consume other meat beside fish the ratio of those who consume poultry and pork is bigger than (or at least) 50%.

n=379 (size of the sample) Poultry and pork: 379 prsns
k=379 (number of interviewed according to null hypothesis) Other meat: 0 prsns
P=0.5000 (the expected value) Summa interviewed: 379 prsns
p=k/n=1.000 (value counted from sample)
Z-test: H_0: $p \geq 0.5$ ← Null hypothesis.
H_A: $p < 0.5$ ← Alternative hypothesis, on the basis of relation sign left-side test. ↓
(At a left-side test we accept null hypothesis if z-value > critical value.)
Level of Significance: α=0.05 (error probability)
Range of acceptance (critical value): $Z_{0.05}$= ─1.645

Z-Test Value: $Z = \frac{k-nP}{\sqrt{nP(1-P)}}$ or $Z = \frac{p-P}{\sqrt{\frac{P(1-P)}{n}}}$ **19.468**

Statistical Conclusion: Z-test value is bigger than critical value → we accept null hypothesis at a 5% significance level, and in the case of 95% probability.
Professional Conclusion: in the examined sample among those who consume other meats beside fish the ones who consume poultry and pork are in majority.

3. **Hypothesis:** Regarding fish consumption, high seasonality can be observed—for example during Christmas period the interviewed consume more fish. With other words: minimum 50% of the examined sample finds that there is seasonality in fish consumption in the Christmas period.

n=429 (size of the sample) Agree with the statement above: 382 prsns
k=382 (number of interviewed according to null hypothesis) Do not agree with the statement above: 47 prsns
P=0.5000 (the expected value) Summa interviewed: 429 prsns
p=k/n=0.8904 (value counted from sample)
Z-test: H_0: $p \geq 0.5$ ← Null hypothesis.
H_A: $p < 0.5$ ← Alternative hypothesis, on the basis of relation sign left-side test. ↓
(At a left-side test we accept null hypothesis if z-value > critical value.)
Level of Significance: $\alpha=0.05$ (error probability)
Range of acceptance (critical value): $Z_{0.05} = -1.645$

Z-Test Value: $Z = \frac{k-nP}{\sqrt{nP(1-P)}}$ or $Z = \frac{p-P}{\sqrt{\frac{P(1-P)}{n}}}$ **16.174**

Statistical Conclusion: Z-test value is bigger than critical value → we accept null hypothesis at a 5% significance level, and in the case of 95% probability.
Professional Conclusion: according to the majority of the examined sample there is seasonality in fish consumption in the Christmas period.

CONCLUSIONS

During this research conducted in the spring of 2017 the price of fish (both live and processed) came along as a fundamental problem to this topic.
After closing my research, back in year 2017, decreasing the VAT-rate of fish and products of fishing formulated as a proposal to me. VAT on fish for consumption purposes decreased to 5% in January, 2018, may increase fish consumption, since fish is becoming more affordable, so demand for fish is expected to increase. The above-mentioned facts enable continuing the examination of the topic.
Moreover, I suggest selling healthy fish in several places, since on the basis of the survey there would be demand for fresh fish in other periods of the year too, not just during the feasts. In my view, domestic fish consumption could be increased if people could purchase excellent quality (and very importantly fresh) fish in several places (SOÓS, 2017). I also propose even a more pronounced advertising of the benefits of fish to the human organism, a clear awareness of this to the people who are currently non-consumers of fish. Since many are not aware how much the numerous vitamins, minerals and unsaturated fatty acids in fish support human organism. I am reassured that the more people are aware of these important pieces of information, the more will consume fish. I find it important that rising awareness should take place in various fields. I feel that attention should be called in schools, too, that fish consumption plays an extraordinary role for our health care. If the student meets already during school years the importance of the endeavour for a healthy way of life as well as its tools (e.g.: fish consumption), in their adulthood, while independent, will take actions for this with higher probability. It could be a solution to call people's attention to the many delicious meals prepared from fish, which will be also healthy - given they are from fish. It does not overload our organism, but all the family

consume it with pleasure. To this topic, I propose distributing recipes of fish-meals and videos demonstrating preparation in the Internet or even on community sites. Summarising information on this topic, we can state that fish consumption is healthy and at the same time it is necessary, too.

ACKNOWLEDGEMENTS

Eszter Ács is supported by the Ministry of Human Capacities, Human Capacities Grant Management Office and the National Talent Program (Proj. No NTP–HHTDK–017–0004).

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

APPLICATION OF SOME LACTIC ACID BACTERIA STRAINS TO IMPROVE FERMENTATION AND AEROBIC STABILITY OF MAIZE SILAGE

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ABSTRACT
The object of the trial was to study the effect of some lactic acid bacteria strains on the fermentation and aerobic stability of whole plant maize silages.
The whole plant maize raw material was 32% DM, in soft cheddar stage of grain ripeness. It was ensiled in 4.2 litre capacity glass micro-size silos in 5 replicates /each treatment and stored on constant air conditioned room temperature (22 ºC) during 95 days. The average packing density of raw material was 211 kg DM/m^3.
The applied treatments: 1. Untreated control maize, 2. *Enterococcus faecium* 100,000 CFU/g fresh maize (FM), 3. *Lactobacillus plantarum* 50,000 CFU/g FM + *Enterococcus faecium* 50,000 CFU/g FM, 4. *Lactococcus lactis* 100,000 CFU/g FM, 5. *Lactobacillus plantarum* 50,000 CFU/g FM + *Lactococcus lactis* 50,000 CFU/g FM, 6. *Lactobacillus plantarum* 100,000 CFU/g FM.
Aerobic stability study: Applied Honig (1990 system).
The main experiences are the following: Applied lactic acid bacteria strains improved the quality of fermentation of maize in general compare to untreated control one.
Lactic acid bacteria strains significantly stimulated lactic acid production and decreased propionic and butyric acid production. The origin of ammonia decreased also under influence of lactic acid bacteria strains in unaerobic conditions.
Enterococcus faecium and.*Lactococcus lactis* are not able to protect the maize silages against the aerobic deterioration with the applied dosage.
Lactobacillus plantarum itself produced the most favourable fermentation characteristics and protected the aerobic stability of silage the most effectively (during 4 day) compare to all other treated maize silages

Keywords: aerobic stability, fermentation, lactic acid bacteria strains, *Lactobacillus plantarum,,* maize silage

INTRODUCTION

Bacterial inoculants are expected to ensure a more efficient fementation phase as well as reduce the risk of aerobic deterioration when silages are exposed to air. Bacterial inoculants can improve fermentation characteristics first of all by speeding up the fall of pH and lowering ammonia levels because of reducing proteolysis into the silo. Various inoculant strains have been found to produce bacteriocins and other compounds that inhibit other bacteria and fungi improving their success (MUCK, 2013). Bacterial inoculants containing homofermentative lactic acid bacteria (LAB), in most of the cases *Lactobacillus plantarum*, secondly Enterococcus faecium, Lactococcus lactis are often added to silage because they very quickly produce large quantities of lactic acid, which lowers the pH of the silage (LI AND NISHINO, 2011; MARCIŇÁKOVÁ ET AL., 2008).
However, some bacterial inoculants often have no effect or can even make the aerobic stability of silages worse (LIN ET AL., 1992; PAHLOW AND HONIG, 1994; MUCK, 2013) because of the reduction of acetic acid (LINDGREN ET AL., 1990; MCDONALD ET AL., 1991; RUSER AND KLEIMAN, 2005) and also because yeasts metabolize lactic acid to produce alcohol (MUCK, 2013).
Recently, the aerobic stability of different silage crops has been markedly improved through inoculation with a heterolactic bacterium eg. *Lactobacillus buchneri, Lactobacillus brevis.* Acetic acid produce from heterofermentative LAB inhibits the

proliferation of yeasts in silage (FILYA ET AL., 2002; RUSER AND KLEIMAN, 2005). Improvements in aerobic stability have been reported in corn silage (RANJIT AND KUNG, 2000; LI AND NISHINO, 2011, 2013).
Many additives have been developed to improve the ensiling process and nutritive value of silages At present biological additives containing lactic acid bacteria strains are preferred because they are non-toxic, non-corrosive to machinery, do not present environmental hazards and are regarded as natural products, and therefore bacterial inoculants have been very popular, over the last 20 years (DAVIES, 2010). Howewer their application cannot replace professional silage management.

MATERIAL AND METHOD

Experimental ensilage procedure
The applied treatments:
T1. Untreated control maize FM (fresh weight)
T2. *Enterococcus faecium* 100,000 CFU/g FM maize,
T3. *Lactobacillus plantarum* 50,000 CFU/g FM
+ *Enterococcus faecium* 50,000 CFU/g FM
T4. *Lactococcus lactis* 100,000 CFU/g FM
T5. *Lactobacillus plantarum* 50,000 CFU/g FM
+ *Lactococcus lactis* 50,000 CFU/g FM
T6. *Lactobacillus plantarum* 100,000 CFU/g FM maize

The inoculants were individually prepared for application by suspending the number of grams to be applied in distilled water and then evenly applying 2 ml of suspension of bacterias / kg of forage (fresh weight). The same amount of distilled water was applied to the untreated maize as well. The maturity of whole plant maize raw material was in soft cheddar stage of grain ripeness and the dry matter content was 32%. The harvested chopped maize was ensiled in 4.2 litre capacity air-tight sealed glass micro-size silos in 5 replicates /each treatment and stored on constant air-conditioned room temperature (22 ^{o}C) during 95 days. The average packing density was 211 kg DM/m^3.

Chemical analysis
DM, pH, lactic-, acetic-, propionic- and butyric acids, ammonia-N and ethanol content of silages were analysed according to the internationally recognised methods.

Examination of aerobic stability
Determination of aerobic stability of silages was monitored by System Völkenrode (Honig, 1990) principle.
It is based on monitoring temperature rise due to increased microbial activity of samples exposed to air.

Procedure
For the determination minimum 100 g samples are weight into a tins. Temperature sensors are placed into the centre of the samples and the whole unit is insulated with an outer layer of polystyrene on the sides and at bottom and top. The temperature is registered hourly by a computer program. From the values of each day a mean value is calculated. The room temperature is taken as the reference temperature about 22 ^{o}C, and substrated from the silage temperatures. The measurement is continued for 7 days.

Evaluation
The time a silage is supposed to be stable is given till the registration unit shows a temperature rise of 3 °C above ambient temperature.

Statistical analysis
Full statistical analyses was using an internationally recognised statistical procedure.
We processed data by means of IBM PC computer with the aid of Microsoft Excel program. As method of mathematical statistics, we used the method of comparison of calculated mean values and significance.
The raw material was analysed before ensilage, and the fermentation products of maize silages were analysed on 95th day after ensiling.

RESULTS AND DISCUSSION

Raw material
The maturity of ensilaged silomaize was at the beginning of soft cheddar stage of grain ripeness. The chemical composition of these plant was similar to the standard average. DM content 32%, which showed easy ensiling of raw material. There was no significant difference between all treatments, neither control nor treated samples, so the further differences in any other parameters were not originated from different DM content.

1. Control silage
After 95 days of storage pH of maize silage was 3.70. Significantly less (P = 0.1%) lactic acid (3.20%) more butyric acid (0.08) % was produced compare to the treated silages. The highest amount of NH_3 (37.4 mg % DM) was detected in control silage compare to different strains of lactic acid bacteria treated silages which was significant in case of T4 (P = 5%), T5 and T6 silages (P = 0.1% respectively) see *Tables 1* and *2*.
The untreated control silage was stable until 3 and half day. The samples started to get warmer on 8th hours and achieved 3 °C warmer temperature compare to ambient on 86th hours (therefore lost stability). Pick temperature was 30 °C on 136th hours (*Table 3*).

2. *Enterococcus faecium* treated silage,
There were significant differences among pH and some fermentation products compare to the control silage:
There was higher pH 3.72 (P = 5%) and lactic acid content 4.4% (P = 0.1%) less acetic acid 1.41% (non significant), butyric acid 0.01% (P = 1%) ethanol 1.8% (ns) and ammonia 34 mg % DM (ns).
The silage was stable less then 3 day only after opening the micro silos on aerobic condition. Getting warmer of silage started from 9th hour, and suddenly rised the temperature with 3 °C higher than the ambient (which indicated the lost of stability) on 71th hour (15 hours earlier than the control).

3. *Lactobacillus plantarum* + *Enterococcus faecium* treated silage
The 3.75 pH and 5.11% lactic acid content of silage is significantly higher (P = 0.1%) to the control silage. Less acetic- and butyric acid, ethanol and ammonia content are not significant compare to control one.
Aerob stability was relatively better than the control.

The stability lasted until 86th hour exposure to air but got worm 3 hours later (11th hour) and the temperature of forages were rising slowly to pick 28 °C until 174th hour which was 38 hours later than the control.

4. Lactococcus lactis treated silage

3.77 pH and 5.12% lactic acid content are significantly higher (P = 0.1%); the same acetic less butyric acid content and higher ethanol production are not significant, while the smaller 27 mg % DM ammonia level is P = 5% significant with control.

The deterioraiton of silage started in the 3rd hour while its stability lasted in the 79th hour (7 hours earlier than the control). Pick temperature (33.2 °C) was achieved in the 123th hour (13 hours earlier than control).

5. Lactobacillus plantarum + *Lactococcus lactis* treated silage

Higher pH (3.77) and lactic acid production (5.40%) and lower acetic acid production (1.26%) were significantly different (P = 0.1%) with control. Also differed significantly the lower butyric acid production (0.006 %) in P = 1% level, and considerably high ethanol (3%) in P = 5% level. Ammonia production was only half (56%) of control, which is significant on P = 0.1% level.

Aerobic stability was kept only 89 hours (3 hours longer compare to control). Silage started to deteriorate from 11th hours (3 hours later) and 37.9 °C pick temperature was achieved on the 115th hours of aerobic stability test (21 hours later than the control silage).

6. Lactobacillus plantarum treated silage

Parameters of fermentation and their significance to the control are the following: higher pH (3.75) P = 0.1%; higher lactic acid (5.19 DM %) P = 0.1% lower acetic acid (1.37 DM %) P = 10%; No butyric acid P = 1%, Half of ethanol content (0.91 DM %) P = 5%; Half of ammonia content (18.1 mg % DM) P = 0.1% level of significance.

These fermentation characteristisc are the best among all other silages, not only in comparison with control, but also with the other lactobacillus bacterium treated silages as well.

The aerobic stability test showed the best results also*:*

Aerobic stability was kept until 95th hour (4 day) (9 hours longer than control). Silage deterioration started on 12th hour (4 hours later than the. control.

The pick temperature 25.7 °C was the lowest, and recorded on 190th hour (54 hours later than control) which means low rising of temperature, slow deterioration of silage.

Table 1. Fermentation product of maize silages on DM basis

Parameters	Mean of treatments (n=5)					
	T1	T2	T3	T4	T5	T6
Dry matter %	31,15	31,92	31,34	31,67	32,22	32,04
Lactic acid %	3,17	4,45	5,10	5,11	5,40	5,18
Acetic acid %	1,46	1,42	1,38	1,47	1,26	1,37
Butyric acid %	0,08	0,03	0,06	0,04	0,01	0,00
Propionic acid %	0,24	0,08	0,18	0,05	0,08	0,13
Ethanol %	1,89	1,78	2,35	2,44	3,01	0,92
Ammonia mg % DM	37,40	33,80	31,80	26,9	20,90	18,00

Table 2. Statistical evaluation of some parameters of the fermentation on 95th day

Parameters	n	Treatment T1 (Control) Mean	T1 s	T2 Mean	T2 s	T3 Mean	T3 s	T4 Mean	T4 s	T5 Mean	T5 s	T6 Mean	T6 s	t*	Level of signif.	Diff. of signif. (p%)
pH	5	3,69	0,01	3,72	0,02	3,75	0,01	3,77	0,01	3,77	0,02	3,75	0,01	t_{1-2}=2,42	5%	0,020
														t_{1-3}=5,27	0,1%	0,040
														t_{1-4}=7,65	0,1%	0,037
														t_{1-5}=8,25	0,1%	0,037
														t_{1-6}=5,84	0,1%	0,037
Lactic acid DM%	5	3,17	0,36	4,44	0,33	5,11	0,55	5,12	0,45	5,40	0,47	5,19	0,45	t_{1-2}=4,61	0,1%	1,036
														t_{1-3}=6,63	0,1%	1,036
														t_{1-4}=7,06	0,1%	1,036
														t_{1-5}=8,07	0,1%	1,036
														t_{1-6}=7,30	0,1%	1,036
Acetic acid DM%	5	1,46	0,16	1,41	0,04	1,38	0,06	1,47	0,05	1,26	0,02	1,37	0,07	t_{1-2}=0,81	ns**	-
														t_{1-3}=1,42	ns	-
														t_{1-4}=0,19	ns	-
														t_{1-5}=3,81	0,1%	0,195
														t_{1-6}=1,73	10%	0,089
Butyric acid DM%	5	0,077	0,03	0,012	0,01	0,056	0,07	0,044	0,04	0,006	0,01	0,001	0,000	t_{1-2}=3,19	1%	0,057
														t_{1-3}=1,00	ns	-
														t_{1-4}=1,61	ns	-
														t_{1-5}=3,29	1%	0,061
														t_{1-6}=3,72	1%	0,057
Ethanol DM%	5	1,89	0,49	1,78	0,77	2,35	0,19	2,44	0,33	3,01	0,75	0,91	1,29	t_{1-2}=0,23	ns	-
														t_{1-3}=0,92	ns	-
														t_{1-4}=1,15	ns	-
														t_{1-5}=2,37	5%	0,971
														t_{1-6}=2,08	5%	0,971
Ammonia mg%	5	37,4	4,74	34,02	5,85	31,78	1,46	26,94	3,26	20,9	5,00	18,10	10,95	t_{1-2}=0,89	ns	-
														t_{1-3}=1,38	ns	-
														t_{1-4}=2,72	5%	7,945
														t_{1-5}=4,29	0,1%	14,464
														t_{1-6}=5,01	0,1%	14,464

*Critical level of „t": $P_{10\%}$:1,71; $P_{5\%}$:2,06; $P_{1\%}$:2,8; $P_{0,1\%}$:3,75
** ns : non significant

Table 3. Summary of aerobic stability test in fermentation study

Treatment	Get warm	Finish of aerob stability	1st Pick temperature		2nd Pick temperature	
	hour	hour	hour	°C	hour	°C
T1	8	86	136	29.9	--	--
T2	9	71	149	28.5	--	--
T3	11	86	174	28.0	--	--
T4	3	79	123	33.2	--	--
T5	11	89	95	37.9	182	38.1
T6	12	95	190	25.7	--	--

CONCLUSIONS

- Applied lactic acid bacteria strains improved the quality of fermentation of maize silages in general compare to untreated control one.
- Lactic acid bacteria strains significantly stimulated lactic acid production and decreased propionic and butyric acid production.
- The origin of ammonia decreased also under influence of lactic acid bacteria strains in unaerobic conditions.
- *Enterococcus faecium* and *Lactococcus lactis itself* are not able to improve the protection of the aerobic stability of maize silages with the applied dosage.
- *Lactobacillus plantarum* applied itself produced the most favourable fermentation characteristics of silage and protected the most effectively the aerobic stability of maize silage (during 4 day) compare to all other lactic acid bacteria strains.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

CO-FERMENTATION OF AGRICULTURAL ORGANIC WASTE, MAIN AND BY-PRODUCTS

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ABSTRACT
My research work proposes the study of the impact of the biogas production by co-fermentation of agricultural products. The basic substance is the dangerous liquid pig manure of the concentrated stock of big pig farms. The utilization of these materials as an energy source spells large income for the agricultural enterprises, saving the replacement of plant nutrition utilization of bio-manure, to increase the performance of the plant production, making harmless the dung which means a big environmental load. Because of the profitability of bioenergy utilization depends on the local conditions it is necessary to do experiments to try the available composition of organic wastes in the ratio of the production in advance. We measured the quantity and the methane and CO_2 content of the biogas released from the substrate. The experiment simulated real biogas plant conditions, in mesophile temperature, in continuous biodegradation process. It can be considered, as a semi-industrial size.

Keywords: sustainable agriculture, environmental protection, increasing the profitability of the agricultural production

INTRODUCTION

It can be provable based on my research and literature references, that the qualitative and the quantitative properties of the biogas releasing in the biogas plants largely depends on the portioned liquid dung, the additives, and the features of the applied technology. Our experiments justified the yield improving effect of the agricultural main and by-products and wastes because of the low organic matter content of the liquid pig manure (ARTHURSON, 2009). It may be hypothesized, that these additives and the technological parameters of the biogas production influence on a favourable direction the features of the fermented manure and through this the opportunities of the recirculation.
My experiments aimed the increasing of the proportion of the renewable energy sources of application, to increase the methane quantity originating from the various organic matters, to increase the intensity of the formation, to produce stabile gas content. Making the organic matters polluting the environment harmless is the indirect result of the application of the technology (GOTTSCHALK, 1979). The biogas increasing the greenhouse effect with big methane content means concentrated environmental load and source of danger and on the other hand unutilized energy source in a farming area where the use of the external power sources is considerable anyway. While the economy size is its principle from below, the relatively little energy content of the biomass in the view of the transportation expense from above limits the firm concentration (GERARDI, 2003). Because of this, it is necessary to examine the energetic utilization of all possible organic waste at least with laboratory or half-firm methods.

MATERIAL AND METHOD

At the Engineering and Agricultural Faculty of Szolnok College, a semi-automatic laboratory system is available, simulating the regular operating circumstances, providing similar conditions suitable for the releasing process of the biogas, adjusting the influencing factors and all the necessary measurements of typical data. Liquid pig manure was used during the biogas production experiments as basic substance.

The supreme features of industrial by-products and wastes suitable for the examination of the biogas production:

- dry matter,
- organic matter,
- nitrogen content,
- C:N proportion,
- specific gas yield.

The technology of fermentation experiments, the process of the experiments is:

a) Loading of laboratory digesters, setting of the treatment combinations
b) Sampling.
c) Measurements, examined parameters

The technology of the co-fermentation experiments
We divided the process of the fermentation into sections according to the *Table 2*.

Table 2. Technology of co-fermentation experiments

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Process period</th><th rowspan="2">Duration time</th><th colspan="2">Treatments, fermenters</th><th rowspan="2">Comment</th></tr>
<tr><th>1.</th><th>2-8.</th></tr>
<tr><td>1.</td><td>stabilization</td><td>7 days</td><td colspan="2">Composition: fresh liquid slurry, in certain cases, wastewater or water</td><td rowspan="2">Same circumstances</td></tr>
<tr><td>2.</td><td>refilling period with fresh substance</td><td>14 days</td><td colspan="2">7 vol. % refilling with fresh substance daily</td></tr>
<tr><td rowspan="2">3.</td><td rowspan="2">refilling with fresh substance daily (running up period)</td><td rowspan="2">21 days</td><td colspan="2">4.4 vol. % refilling with fresh substance daily</td><td rowspan="4">32 – 37 °C different process</td></tr>
<tr><td>control</td><td>different amounts of additives</td></tr>
<tr><td rowspan="2">4.</td><td rowspan="2">refilling with fresh substance daily (comparative experiments)</td><td rowspan="2">21 days</td><td colspan="2">4.4 vol.% refilling with fresh substance daily</td></tr>
<tr><td>control</td><td>different amounts of additives</td></tr>
</table>

We dosed ~50 dm^3 of liquid dung mixture pro treatment to take the factors in connection with the capacity of the fermenters into account (SALLAI, 2016). We applied the continuous (filling up) system, which is most widespread in the practice, it can be reproduced the process sections, as the launching, load change, receipt change, according to certain expert opinions each single daily measurement combination for a separate experiment can be qualified (KALMÁR ET AL., 2003).

We measured the quantity and the methane content of the releasing biogas, the dry matter and organic matter content, pH value ratio of C/N of the substrate during experiments by co-fermentation of liquid pig slurry and by-products of food industry and bio-fuel industry.

Statistical methods used for the evaluation of co-fermentation experiments

For the statistical analysis, we used Excel spreadsheet and SPSS for Windows 18.0. The data were analysed by variance with independent two-T sample. We examined the homogeneity with Levene test. By the group pair comparison, we used Tamhane test in the case of heterogeneity, and LSD test in the case of homogeneity (SALLAI, 2014). The relationship between variables was performed with correlation analysis tests (Pearson's correlation coefficient) and linear regression analysis.

RESULTS

Gas releasing in the case of mushroom compost and controls

By the slurry-based controls, the bigger dry matter content (3.4 - 4.6%) increased the average gas releasing (16.98 - 23.04 dm^3/day) and 35% average dry matter content increased nearly 35% in the amount of gas (*Table 2*). The 30 g (dry matter content) yielded mushroom compost additive in approx. 2000 g dry matter pro digester of liquid pig manure containing increased 70% in production (16.98 << 29.00 Ndm^3/day) and decreased 4.4% methane content (58.9 > 54.5%). This is 60% excess amount of energy produced in the methane production (*Table 2*).

Table 2. Parameters of gas releasing in the case of mushroom compost and controls

Load of digester/day; dry matter, treatment	Average dry matter content (%)	Gas releasing (Ndm^3/ day)	Methane content (%)	Specific digester volume referred	
				biogas-production	methane-production
Control I.	3.40	16.98	58.92	0.34	0.20
Control II.	4.59	23.04	59.07	0.46	0.28
30 g DMC (0.06-0.07%)	3.80	29.00	54.50	0.58	0.32

Among the organic matter additives, whole plant additives produced the lowest methane production (hemp, Sucrosorgho 506, C_{36}, Berény sugar sorghum, C_{35} (0.4, 0.4, 0.45 dm^3 methane/dm^3/day) (*Table 3*).

Table 3. Parameters of gas releasing in the case of whole plant additives

Reactors, treatment: liquid pig slurry (4% DMC) + additives	refilling with fresh substance (V/V %/day)	DMC of additive (g/day)	average biogas yield (dm^3/ d)	methane content (%)	methane production related to specific reactor volume (dm^3/dm^3 d)	
1. digester (control)	4.4		21.0	60.5	0.42	0.25
2. digester: Berény sugar sorghum, C35, 30 g d.m./ day	4.4	30	42.2	53.6	0.84	0.45
3. digester: Sucrosorgho 506 sugar sorghum k, 30g d.m./ day	4.4	30	33.8	59.2	0.68	0.40
4. digester: hemp, 30 g d.m./ day	4.4	30	36.1	54.8	0.72	0.40

The specific methane yield of sugar sorghum press residue (100 g DMC. loading) was the most intensive (Reno, Berény, Runa - bacteria treated, 1.0, 0.96, 0.93 dm^3 methane/dm^3/day) but the bacteria treatment did not increase the digestion (*Table 4*).

Table 4. Parameters of gas releasing in the case of different species sugar sorghum press residue

Reactors, treatment: liquid pig slurry (4% DMC) + additives	refilling with fresh substance (V/V %/day)	DMC of additive (g/day)	average biogas yield (dm^3/d)	methane content (%)	methane production related to specific reactor volume (dm^3/dm^3 d)	
control	5		35.2	55.2	0.70	0.39
Berény sugar sorghum, press residue	5	100	86.1	55.5	1.72	0.96
Róna sugar sorghum, press residue	5	100	90.0	55.4	1.8	1.00
Róna sugar sorghum press residue +bacteria	5	100	82.9	55.8	1.66	0.93

The co-fermentation of the yielded mushroom compost and the maize silage provided the best equipment – energy utilization even without bacteria treatment (0.73 dm^3 methane / dm^3/day), while the addition of bran itself resulted similar specific methane yield (0.72 dm^3 methane / dm^3/day). In this case, the utilisation of the bacteria does not increase methane production (0.65 dm^3 methane/dm^3/day) related to the reactor volume (*Table 5*).

Table 5. Parameters of gas yield in the case of mushroom production by-products

Reactors, treatment: liquid pig slurry (4% DMC) +additives	refilling with fresh substance (V/V %/day)	DMC. of additive (g/day)	average biogas yield (dm^3/ d)	methane content (%)	methane production related to specific reactor volume (dm^3/dm^3 d)	
control (3.4% DMC)	5		17	58.9	0.34	0.20
control (4.59% DMC)	5		23.	59.7	0.46	0.28
100% mushroom compost, without bacteria	5	30	29.	54.5	0.58	0.32
100% mushroom compost, 1.3l bacteria treatment	5	100	63.3	50.5	1.27	0.64
75% mushroom compost + 25% frozen, Berény sugar sorghum press residue (PSSPR)	5	60	48.7	55.1	0.97	0.54
75% mushroom compost + 25% dried, (PSSPR), 1.3l bacteria treatment	5	100	66.	50.3	1.32	0.66
50% mushroom compost + 50% dried, (PSSPR), 1.3l bacteria treatment	5	100	71.3	50.3	1.43	0.72
75% mushroom compost + 25% corn silage	5	100	74.47	48.9	1.49	0.73
50% mushroom compost + 50% corn silage	5	100	58.16	40.4	1.16	0.47

We tested the capability of use and the biogas release influencing impact of sunflower pellet and the maize pomace in the consideration of quantity and methane content with and without bacteria treatment. In the case of properly selected germs were not only the quantity of the forming gas increasing remarkably, but the methane content too, which wasn't noticed in the case of neither additives nor additives bacteria treatment (*Table 6*).

Table 6. Parameters of gas yield in the case of bio-fuel production by-products

Reactors, treatment: liquid pig slurry (4% DMC) +additives	refilling with fresh substance (V/V %/day)	DMC. of additive (g/day)	average biogas yield (dm^3/d)	methane content (%)	methane production related to specific reactor volume (dm^3/dm^3 d)	
control	5		41.83	57.	0.84	0.48
sunflower granulate	5	100	72.56	57.6	1.45	0.84
corn pomace	5	100	74.55	54.5	1.49	0.81
sunflower granulate, + bacteria	5	100	58.1	54.5	1.16	0.63
corn pomace + bacteria	5	100	82.89	58.	1.66	0.96
bran + 1*bacteria, bacteria treatment 3	6.6	45/60	55.1	58.6	1.10	0.65
bran	6.6	45/60	62.7	57.	1.25	0.72

The water-based, pure bran starting treatment for biogas production is special bacteria was able to increase. The relative effectiveness of recirculation technology here refers to the slowing degradation. The liquid pig manure based on 6.6 V / V% loading, dry matter content. 45 g / day of wheat bran in dosing gas production more than doubled the methane content to 5%, the influence of the bacterial treatment increased by 7.5%. Generally, the methane content of by-products was reduced by the bacterial treatment, the gas production was increasing, but in the case of wheat bran, we didn't notice. The bacterial treatment didn't increase the performance of the bran additive, but the methane content was growing, which has been unique among the experiments (*Table 7*).

Table 1. The average gas production of the fermentors in the course of the comparative experiments, with wheat bran additive

Reactors, treatment: liquid pig slurry (4% DMC) +additives	refilling with fresh substance (V/V %/day)	DMC. of additive (g/day)	average biogas yield (dm^3/d)	methane content (%)	methane production related to specific reactor volume (dm^3/dm^3 d)	
bran + bac. treatment 3 recycling technology	6.6	45/62	40.9	57.7	0.82	0.47
bran, recycling technology	6.6	45/62	42.0	57.62	0.84	0.48
control, recycling technology	6.6		10.1	62.38	0.20	0.13
bran + water +2* bac. treat., recycling	6.61	45/60	22.9	46.29	0.46	0.21

CONCLUSIONS

The biogas production based on the pork liquid dung, and the other wastes of agricultural main product of processing known, and accepted technological procedure in the EU's member states, as the result of this biogas and fermented manure is produced. The quantity and the quality of the raw materials and additives, the parameters of the applied technology and the biogas forming are strongly depending.

At the end of the comparative experiments we can determine, that the utilization of the different additives increases the biogas production of the liquid pig slurry, and the difference of this significantly bigger, than the decreasing of the methane content. The justification of the relation between the connection of the maturation degree and the value of the sugar content and another properties of the different additives needs further investigations.

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Review on Agriculture and Rural Development 2018 vol. 7 (1-2) ISSN 2063-4803

MICROBIOLOGICAL STATUS AND OXIDATION PROPERTIES OF MINCED CHICKEN BREAST MEAT TREATED WITH DIFFERENT CONCENTRATIONS OF ALLYL-ISOTHIOCYANATE

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ABSTRACT
Due to its biological composition, poultry meat is perishable by nature and susceptible to quality deterioration such as microbial spoilage and oxidation changes. Meat and meat products with healthy, extended shelf-life and good organoleptic properties are highly demanded by consumers. In current study, the antimicrobial and antioxidant effects of allyl-isothiocyanate (AITC) as a natural additive on raw chicken meat during chilling storage were determined. For this purpose, samples of minced were treated with different concentrations of AITC (100, 200, 300 and 500 ppm) and control no AITC added, the samples packaged and stored for 8 days at 4 °C. Fluctuations with no significant effect were noticed in TBARS values during the storage period. Simultaneously, AITC with higher concentration showed lower mesophilic aerobic counts compared to control and meat containing a low concentration of AITC. Moreover, compared to the beginning of storage, AITC decreased water holding capacity (WHC) of meat this can affect other physicochemical properties of meat. Further study needed to determine the effect of AITC on the physicochemical properties of meat and food products.

Keywords: chicken meat, allyl-isothiocyanate, lipid oxidation, microbiological properties, refrigeration storage

INTRODUCTION

Poultry meat and particularly chicken is the cheapest commercially produced meat, it is supposed to have an increase in consumption by 34% by 2018 (JUNG ET AL., 2011). Poultry meat is highly perishable in nature, it is prone to quality deterioration, which affects quality characteristics and can lead to undesirable reactions because it contains higher levels of unsaturated fatty acids compared to red meat (LUCERA ET AL., 2012). The principles of meat preservation are mainly associated with preventing or delaying microbial spoilage and chemical action and avoiding as far as possible any organoleptic changes. Therefore, if the meat and meat products are not preserved and handled properly, it could be a common vehicle for foodborne diseases, enhanced rancidity and it compromises the nutritional quality. Eventually, it influences product acceptance by consumers causing food insecurity and economic loss. The consequences of microbial spoilage and oxidation changes can be limited or inhibited using natural additives of plant origin which have been used as an alternative to synthetic food additives. These natural preservatives possess properties for extending the shelf-life and improving product quality. Allyl isothiocyanate (AITC) (CH_2=CH-CH_2-N=C=S) is one of many natural non-phenolic volatile sulphur compounds that are found in the seeds, stems, leaves, and roots of cruciferous plants (Brassicaceae family), its alos are found in horseradish, cabbage, wasabi, brussels sprouts, broccoli and cauliflower (CORRALES ET AL., 2014). The volatile oil of mustard consists almost entirely of AITC (93-99%) (THOMAS ET AL., 2004). It is legalized to be applied as food additives and GRAS flavoring agent in different food systems in several countries such as USA and

Japan. It has been noted as natural flavoring, it could possess antioxidant characteristics and it is applied as an antispoilage agent in food at low concentrations (EFSA, 2010) It has been reported that the effectiveness of AITC in inhibiting bacteria at all growth stages support its application in food preservation (LIN ET AL., 2000). The aim of current study was to investigate the influence of different concentrations of AITC on the microbiological status and oxidation properties of minced chicken breast meat.

MATERIAL AND METHOD

Fresh chicken breast meat 24 hours' post-mortem was obtained from a local slaughterhouse (Budapest-Hungary) and transported to laboratories (Faculty of Food Science - SZIU). The meat then was cut and minced (free from bone, connective tissue, skin and visible fat), homogenized and divided into samples of four groups. Control (sunflower oil only) and three treatments were mixed with 100, 200, 300 and 500 ppm AITC and 5% oil. Then the samples were placed in polyethylene bags, packaged and stored at 4 ± 0.5 °C for up to 8 days. The samples were then taken at different time intervals for different analyses.

Lipid oxidation

Lipid oxidation was measured by analysing TBARS using the method described by GANHÃO ET AL. (2011), slightly modified as follows. Chicken meat of 4 g was dispensed in mixing glass tubes and homogenized with 20 mL of distilled water. Then 5 mL of 25% trichloroacetic acid (TCA) was added to the mixture then homogenized with a centrifuge 5,000 rpm for 10 min. The homogenized aliquot supernatant was filtered through filter paper (diameter 11 cm). Then, 3.5 mL of this solution was removed and added to 1.5 mL of 0.6% thiobarbituric acid (TBA) (0.02 M). The tubes were placed in a boiling water bath and kept at 100 °C for 30 min. After cooling, absorbance readings were taken for glass cuvette containing samples against the blank (3.5 mL 25% TCA and 1.5 mL 0.6 M TBA). with usning a Spectrophotometer (U2900-HITACHI Ltd., Tokyo, Japan) at 532 nm against a blank. TBARS were expressed as mg malonaldehyde (MDA equivalent) /1000 g sample.

Microbiological analysis

Microbiological analysis of meat was carried out through analysing population of aerobic mesophile counts after treatments and during storage. Ten grams of each sample in triplicate were measured aseptically into sterile stomacher begs, stomachered for 2 min with 90 mL of MRD diluent, and 10-fold serial dilutions were made. The appropriate dilutions were pour plated on nutrient agar. Plates were then incubated for 48 h at 30 °C, and the colonies were counted by a colony counter. Microbial data were transformed into logarithms and the results were expressed as (LogCFU/g) (APHA 2001).

WHC Measurement

Measurement of WHC was performed using a press technique explained by OZTAN AND VURAL (1993) with a slight modification. A sample (0.25-0.32 g) was placed on a filter paper (Whatman no. 10), set between 2 Plexiglas plates and pressed for 5 min by a 500 g weight. The outlined area of the expressible liquid and the pressed meat film were traced. The filter paper was then placed in an oven for 10 min followed by 5 min in a desiccator. WHC was calculated as a ratio of meat film area-to-total liquid area. It should be noted that a higher expressible liquid area was related to reduced WHC (higher drip loss).

RESULTS AND DISCUSSION

TBARS values

The result from lipid oxidation is presented in *Figure 1*. Fluctuations with no significant effect were noticed in TBARS values during the storage period. Protective effect of 200 and 300 ppm AITC against lipid oxidation were seen by keeping TBA scores lower than 2 mg MDA/kg during storage ($P<0.05$). It has been reported that TBA ≥ 5 mg MDA/kg meat comprise the threshold for detecting off-flavour for humans (KARABAGIAS ET AL., 2011).

Microbiological analysis

The results from the microbiological effect of all treated samples, 100, 200, 300 and 500 ppm are presented in *Figure 2*. It was observed that the meat containing higher concentration AITC showed lower mesophilic aerobic counts compared to control and meat containing a low concentration of AITC. Similar to current study, NADARAJAH ET AL. (2005) tested commercial AITC in fresh ground beef. They observed that the total bacterial population increased from 3.6 to 7.3 $\log^{10}$CFU/g in the control samples, they also found that the bacterial population reached 6.5 $\log^{10}$CFU/g 0.5 mL for AITC-treated samples after storage at 4 °C for 21 days. The antimicrobial mechanism of isothiocyanates has not yet been fully elucidated, it is believed to be associated with sulfhydryl-containing enzymes (LUCIANO AND HOLLEY, 2009). It can be highlited the AITC has potenial to extend shelf-life of fresh meat.

Water holding capacity

The WHC results are presented in *Figure 3*. The AITC did show some effect on the WHC chracterisics of meat compared to untreated samples especially with 300 ppm. However, 500 ppm showed decreased WHC compared to first day of storage. Additonally, a decrease in WHC of meat can affect other physicochemical properties of meat such as; colour lightness, a decline in pH, ionic strength, increase oxidation) (HUFF-LONERGAN AND LONERGAN, 2005).

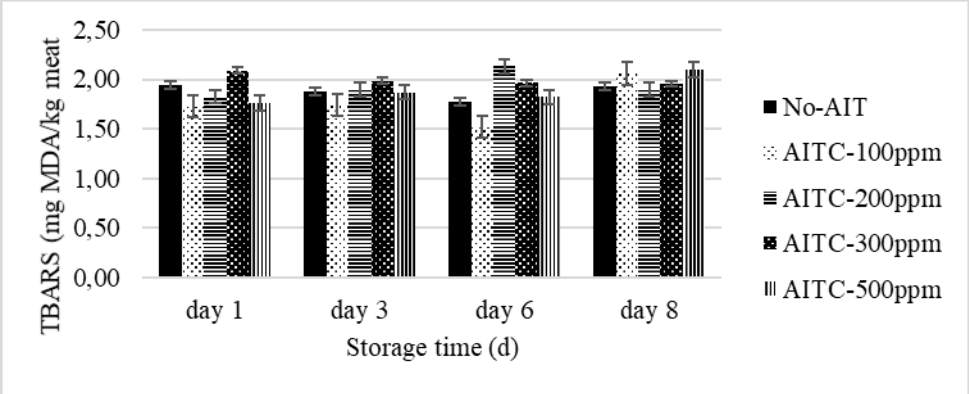

Figure 1: The influence of different concentrations of AITC on TBARS of fresh chicken meat stored for 8 days at 4 °C

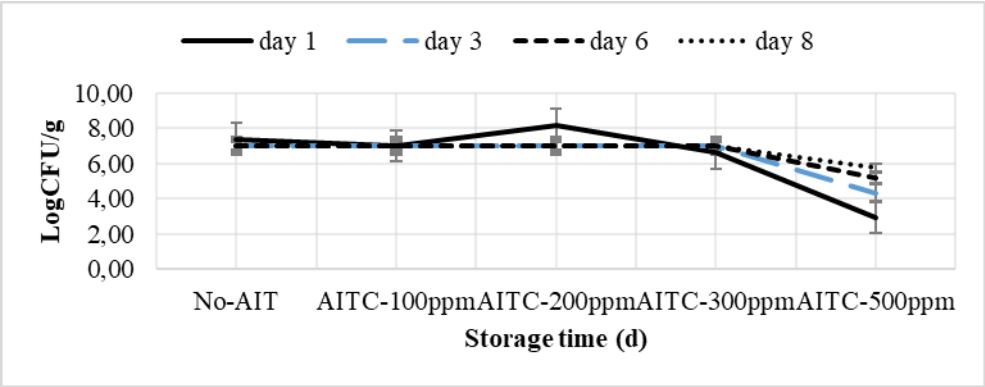

Figure 2: Efficacy of different concentrations of AITC on aerobic mesophilic counts of chicken meat stored for 8 days at 4 °C

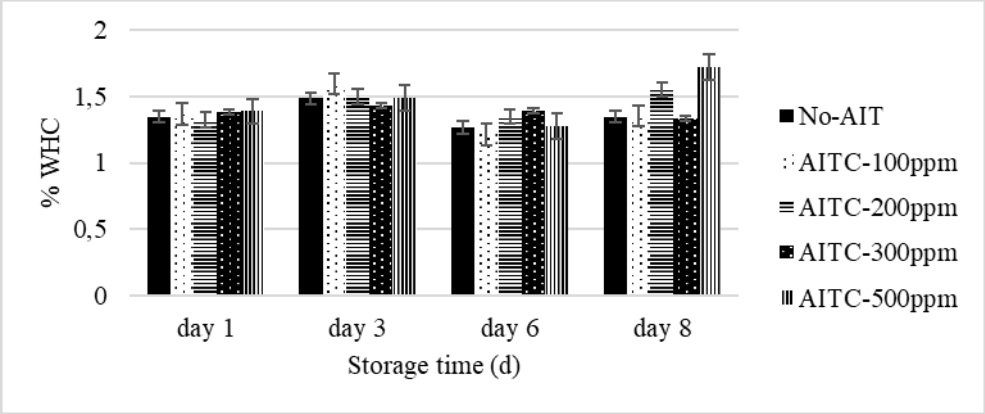

Figure 3: The influence of different concentrations of AITC on WHC of fresh chicken meat stored for 8 days at 4 °C *(p<0.05)*

CONCLUSIONS

The application of various concentrations of AITC into the chicken breast had shown the fluctuations with no significant effect in TBARS values during the storage period. Additionally, AITC of higher concentration showed lower mesophilic aerobic counts compared to control and other meat groups. Moreover, compared to the beginning of storage, AITC decreased WHC of meat. Future studies are required to determine the effect of AITC on the physicochemical properties of meat and food products.

ACKNOWLEDGEMENTS

The authors would like to thank laboratory technicians and the Doctoral School of Food Sciences (SZIU) for their support. Supported by the EU and European Social Fund, Project No. EFOP-3.6.3-VEKOP-16-2017-00005.

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